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POWER

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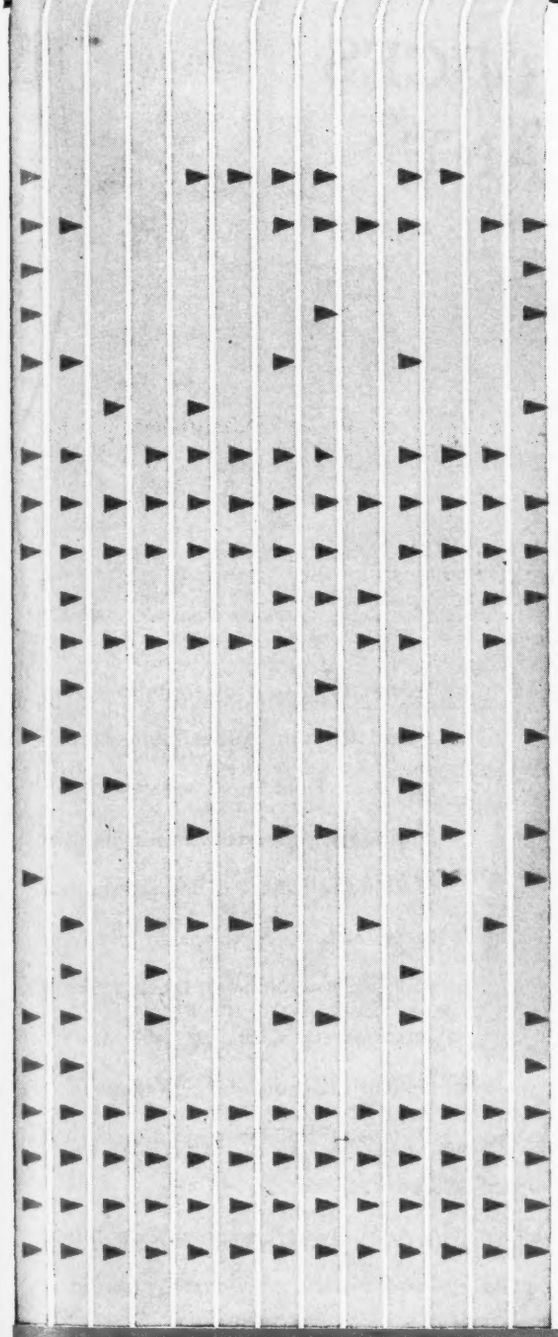

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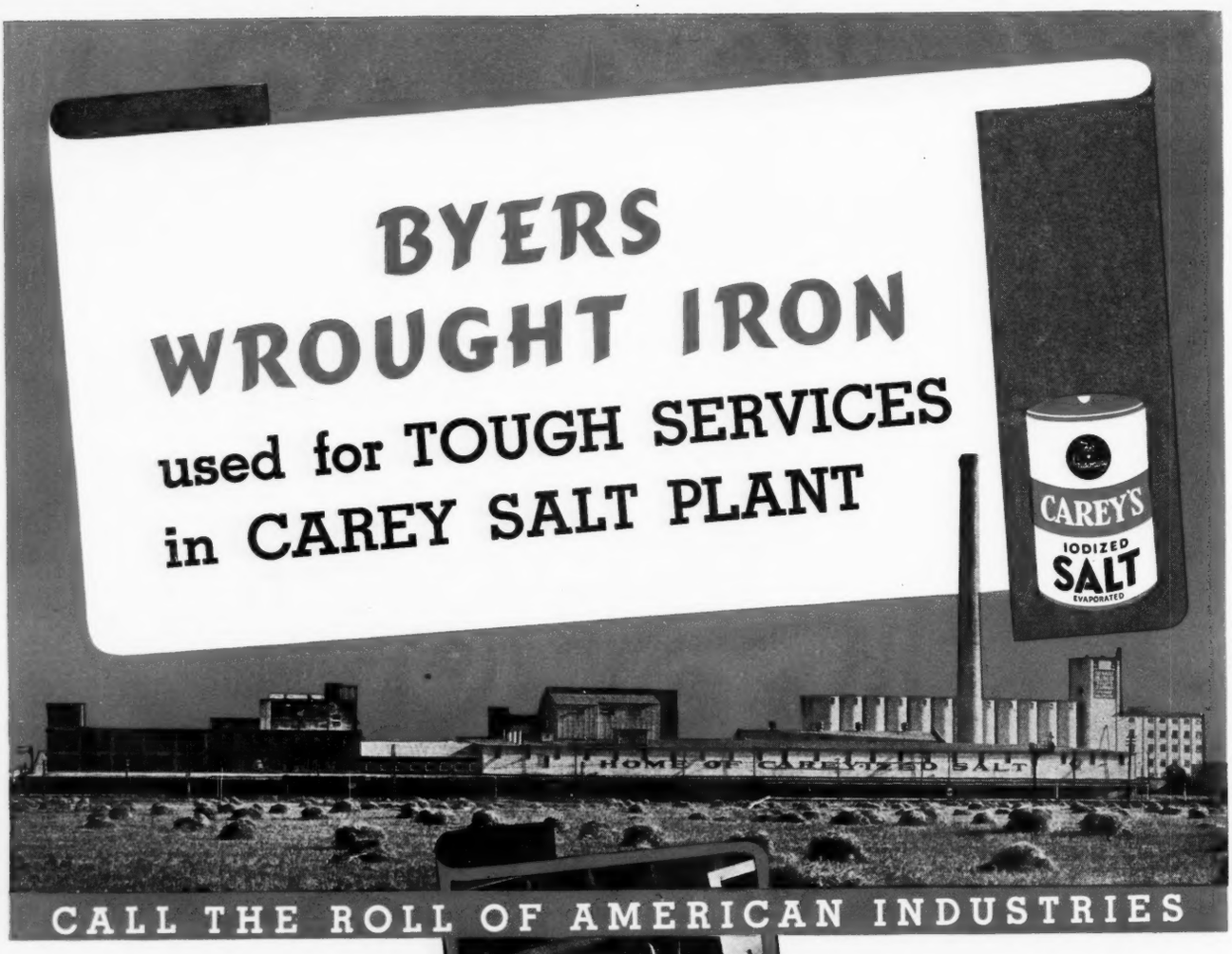

● Few plant services are as tough on equipment as at the Carey Salt Company. If you are having trouble with premature failures in tanks, process or pipe lines, here is sufficient evidence to justify your use of Byers Wrought Iron.

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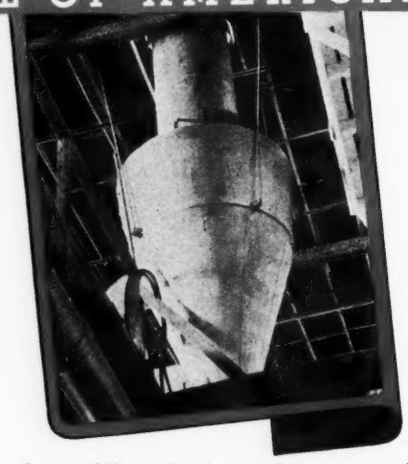

Byers Wrought Iron plates were ● also used for brine filter tanks, and much of the piping in the evaporator unit is Byers Wrought Iron, as well as the cooling water lines to and from the compressor unit.

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POWER

A McGRAW-HILL PUBLICATION — ESTABLISHED 1882 — PHILIP W. SWAIN, EDITOR

SPRINGBOARD OF 1937

Radicalism in power-plant design means leaping far beyond today's experience. We do not recommend it for the average plant owner, but admire the great organizations that have the will to pioneer and the resources to stand occasional loss from such experimentation.

Now look at the other extreme! "Conservatism" in plant design, as some would interpret the word, means starting where one's personal experience left off. In most cases this means not later than 1929. It's more likely to be 1920, for thousands of power plants have installed no major units since that date. No good word can be said for this brand of conservatism. It has nothing in common with common sense.

To clear the way for a discussion of this point, let's review some elementary and long-known principles of power economics.

First: The total cost of generating the power services is the operating cost plus the fixed charges.

Second: The two major elements of fixed charges are interest on investment and "depreciation."

Third: "Depreciation" charge is the yearly "deposit" in a real or imaginary sinking fund which will accumulate to the cost of a replacement plant when the present plant has completed its useful life.

Fourth: Technological changes will generally make a plant obsolete before it wears out. In most cases, therefore, the so-called "depreciation" is nothing but obsolescence.

Fifth: Thus, in most cases, fixed charges consist mainly of interest and obsolescence.

Sixth: A plant is obsolete when the best-available replacement plant would save enough in operating cost to pay its fixed charges.

All this is A-B-C, yet its tremendous practical significance is persistently overlooked by the too conservative. Right now such oversight is particularly costly. Let's illustrate:

Two owners will build power plants in 1938. Owner A will start with the best practice of 1937. Owner B plays safe; won't step beyond his personal experience. So his new plant is merely a replica of the "last word" of 1927.

If 20 years happens to be the time required for a really modern plant, built today, to become obsolete, B will be economically "through" in ten years, because his installation was ten years old, technically, the day it was born.

Neglecting compound interest on the sinking funds, and assuming that both plants cost $200,000 to install, Owner B carries an excess power cost of $10,000 annually. This is a net deduction of $10,000 from the yearly profits of the business.

After the long siesta of depression years we are again in an era of intensive plant construction. Hundreds of millions will be spent yearly for power-service equipment. In a few years two billions will be spent. If half of this investment goes into "conservative" designs, as just defined, it will mean an additional national power cost of about $50,000,000 annually for at least a decade.

The individual building today may avoid any share in this potential loss by taking off from the springboard of 1937. If his own latest installation dates back to 1927, or even 1920, that fact need make no difference. He can lean on the experience of others, as summarized, for example, in Power's "Modern Plant Number" (Mid September).

Studying what progressive power engineers are doing *today* is the beginning of wisdom in plant construction.

Air Conditioning The Ford Engineering Laboratory

Availability and cost of condenser water, plus the fact that steam power was close at hand, determined the selection of water-vapor as the refrigerant, direct-expansion cooling as the method, and steam turbines as the drive

By Herbert E. Ziel

Chief Engineer, Air Conditioning Div., Albert Kahn, Inc.

IN ACCORD with its policy of providing the best possible working conditions for its employees, the Ford Motor Co. some time ago decided to air-condition all of its important buildings, one of which is the Engineering Laboratory at Dearborn, Mich., built in 1924. At the time of its construction a complete heating and ventilating system was installed, but refrigerating equipment wasn't added until 1935.

Putting in air conditioning in an existing building usually involves special problems, which have a definite influence on the type of equipment to be used as well as the method of installation. The solution of these problems tends to increase the cost of installation over an air-conditioning system built integrally with a building. Under ordinary circumstances, however, cost of operation is not affected, as has been demonstrated by this particular installation, which is being operated at the low cost of a little over one cent per ton per hr.

The Building

The Engineering Laboratory is a single-story structure, 800 x 200 ft. Except for a small section partitioned off for offices, the entire floor is one large open space. When the building was designed, one requirement was that all piping, conduits and duct work be kept concealed or built into the structural portion of the building.

Original heating and ventilating system for the building, exclusive of the office section, consisted of four fan units, each capable of handling 60,000 cuft of air per min. These units are installed in fan rooms below the first floor. Fig. 1 shows one of the four units with direct-connected dc motors, piping connections and reheating coils. The two cork-covered chilled-water lines in the background connect to new chilled-water cooling coils.

Conditioned air from the fan units is supplied to the building through outlets in the main columns. The two outer rows of hollow-box columns have internal cores that accommodate the supply ducts. The inner rows are round, Fig. 2, with their lower sections encased in steel cylinders which serve as duct spaces. The upper part of each steel enclosure has an outlet grille; and the concrete on the upper part of each column, built out flush with the steel-plate enclosure, gives the column a massive appearance.

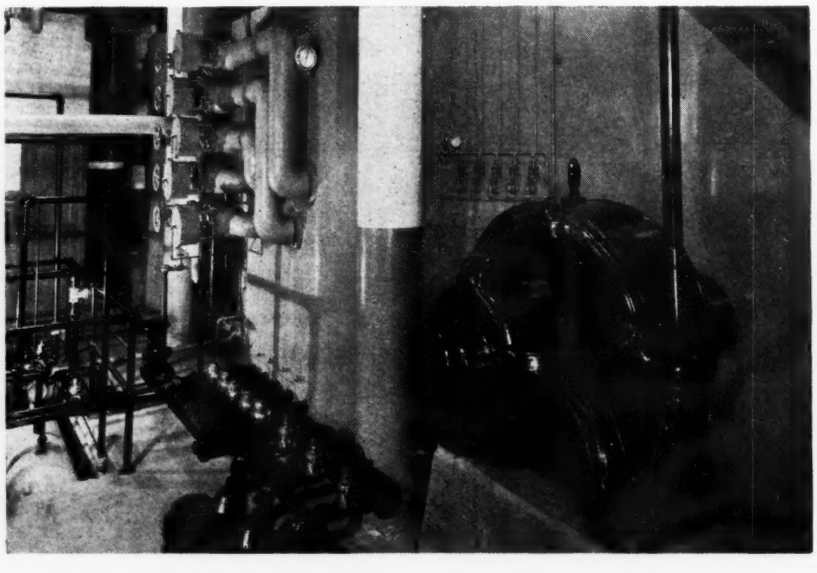
All duct work is completely concealed. The duct-distributing system is in the pipe space under the first floor, and branches connect to column-duct spaces under the floor. Excavated space under the floor makes it possible to connect quickly service piping and wiring to individual machines on the floor, with the result that no process piping or power wiring can be seen in the laboratory.

A separate ventilating system has been built to air-condition the office section, which required additional ductwork when the system was modified to embody air cooling. At the time the building was erected, air-supply outlets were near the ceiling of the inner offices, and exhaust outlets near the floor on the outside wall. With the addition of a cooling system, an air-supply outlet was required for each office. New ducts were extended to the outer offices from the registers in the inner offices, and registers added.

Selection of the refrigerating equipment was governed by two factors; namely, the amounts of condenser water and power available. The Laboratory is in Dearborn, which is supplied with water by the Detroit Water Board. Rates for Dearborn are practically double the rates charged in Detroit, which made the use of purchased condenser water prohibitive. A suitable supply of well water could not be obtained, and a cooling tower was deemed objectionable because of possible "vapor drift" and because it would mar the appearance of the building.

In the immediate vicinity of the Laboratory are two natural ponds having a combined area of approximately 20 acres, Fig. 3. The ponds are shallow, average depth being approximately 3 ft. Consequently, to use the ponds for cooling would require returning all condenser water. During the summer months the water in these ponds reaches a temperature of 85 F, and it was calculated that return of condenser water would raise

Fig. 1—One of the four fan units, showing dc motor, completely-enclosed fan, piping and wiring conduits



temperature to 90 F or more. However, as the water was obtainable at the cost of pumping, emphasis was placed on selecting refrigerating equipment that could use this water, under the conditions mentioned.

The second important consideration governing selection of the refrigerating equipment was the source of power. The power house, about 1,200 ft. from the Laboratory, has three 10,000-sq ft Sterling boilers and two 2,080-sq ft Badenhausen boilers, which, in addition to some process-steam requirements, carry heating and hot-water loads during the winter. In the summer, hot-water and process-steam requirements are less than 10% of normal winter load, thus making available for summer use steam of more than 3,000-bhp capacity at 175 lb g pressure.

Under ordinary circumstances, carbon dioxide would have been the most satisfactory refrigerant for direct-expansion cooling, which is the desirable method when the cooling coils of the air-conditioning system are some distance away from the refrigerating compressors. With the CO_2 direct-expansion method, only 3 lb of liquid refrigerant has to be pumped per ton of refrigeration; with chilled water, 33 lb of water must be pumped to obtain the equivalent of one ton of refrigeration.

However, as the available condenser water might reach 90 F or more, and the critical temperature of carbon dioxide is 87.6 F, CO_2 could not be used as the refrigerant. Ammonia as a refrigerant was thought too hazardous; others considered were Freon, "Carrene," and water vapor, each of which would operate satisfactorily with the high-inlet temperature of the condenser water.

Water vapor was finally selected as the most desirable because (1) a water-vapor machine could operate on the high temperature of available condenser water, (2) it requires a high rotative speed which can be easily obtained with a steam turbine, and (3) water vapor is comparatively inexpensive.

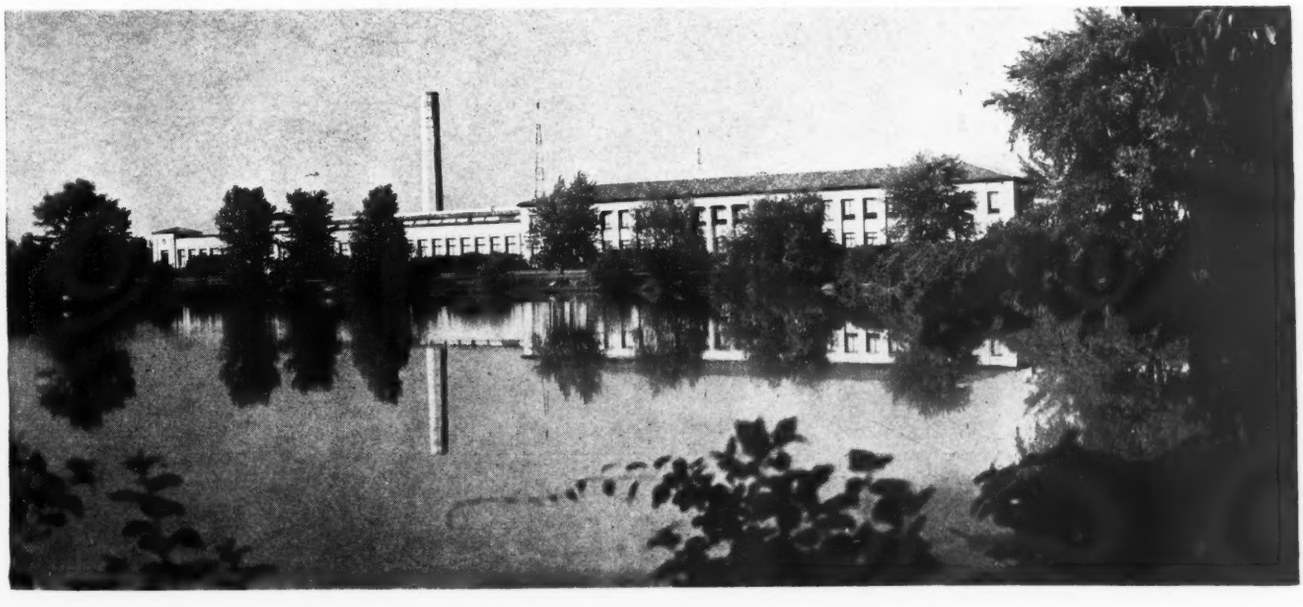
Fig. 2 — Round center columns are enclosed in steel cylinders which serve as ducts. Square columns in the background are cored out to act as ducts

The two refrigerating compressors, Fig. 4, selected are centrifugal steam-driven units, each consisting of: a 320-ton water-vapor compressor, a 315-hp steam turbine, Fig. 5, surface condenser for the compressor, surface condenser for the steam turbine, one condenser pump, and a 2-stage steam-jet vacuum pump with surface-type inter- and after-condensers.

We ordinarily think of the boiling point of water as 212 F, which is at sea-level pressure, but the boiling point is raised by increasing the pressure and lowered by decreasing the pressure. The centrifugal compressor lowers the absolute pressure over a body of water, thus lowering the boiling point. A partial vacuum corresponding to 0.18 lb abs reduces the boiling point of water to 50 F, and a further reduction to 0.12 lb abs lowers the boiling point to 40 F. The lowest practical range for a water-vapor compressor is between 40 and 50 F, which is also the practical range for air-conditioning work. This property of water vapor lends itself admirably to regulation of temperature and dew point for air-conditioning.

Thus, as refrigeration load drops, water pressure drops as well. This parallels atmospheric conditions; that is, when the total sensible heat (heat above zero F) drops, the latent heat (heat required to change a liquid to

Fig. 3 — One of the two natural ponds from which condenser water is taken, with the laboratory in the background



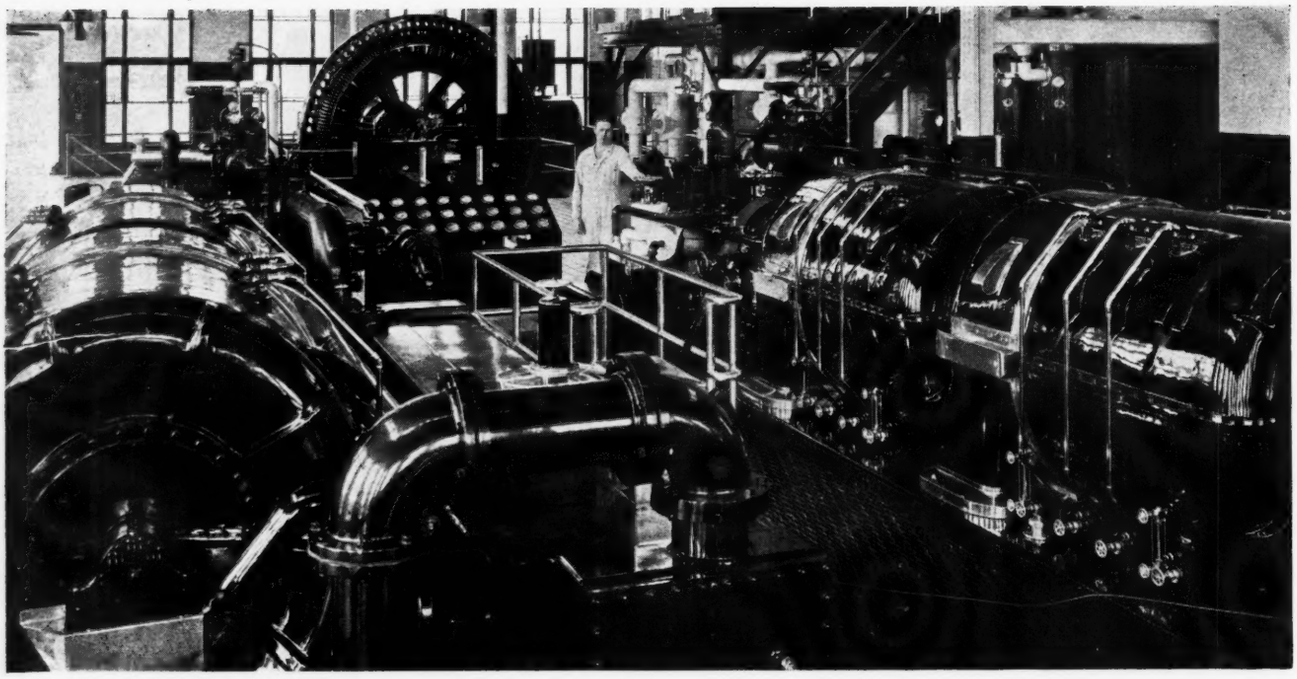


Fig. 4 — End view of centrifugal water-vapor compressors opposite their steam-turbine drives

its gaseous state at the same temp.) remains nearly constant, and a greater dehumidifying load is required. This can be effected with the cooler chilled water obtained from the compressor when it is operating under reduced total loads.

The centrifugal compressors supply chilled water to coils of the air-conditioning equipment at 45 F, return temperature being 51.4 F. With this temperature differential, 2,400 gpm of chilled water must be pumped from the power house to the units in the Laboratory. 2,300 gpm of water must also be pumped from the ponds, which serves both refrigerating condenser and steam-turbine condenser.

Electric power necessary for all water pumps is 274 hp or 204 kw Steam consumption for the turbine, based on a rate of 16.7 lb per indicated hp, together with consumption of the vacuum pump, is 11,100 lb per hr. Thus the total load required to supply chilled water to the five air-conditioning units and for circulating condenser water is:

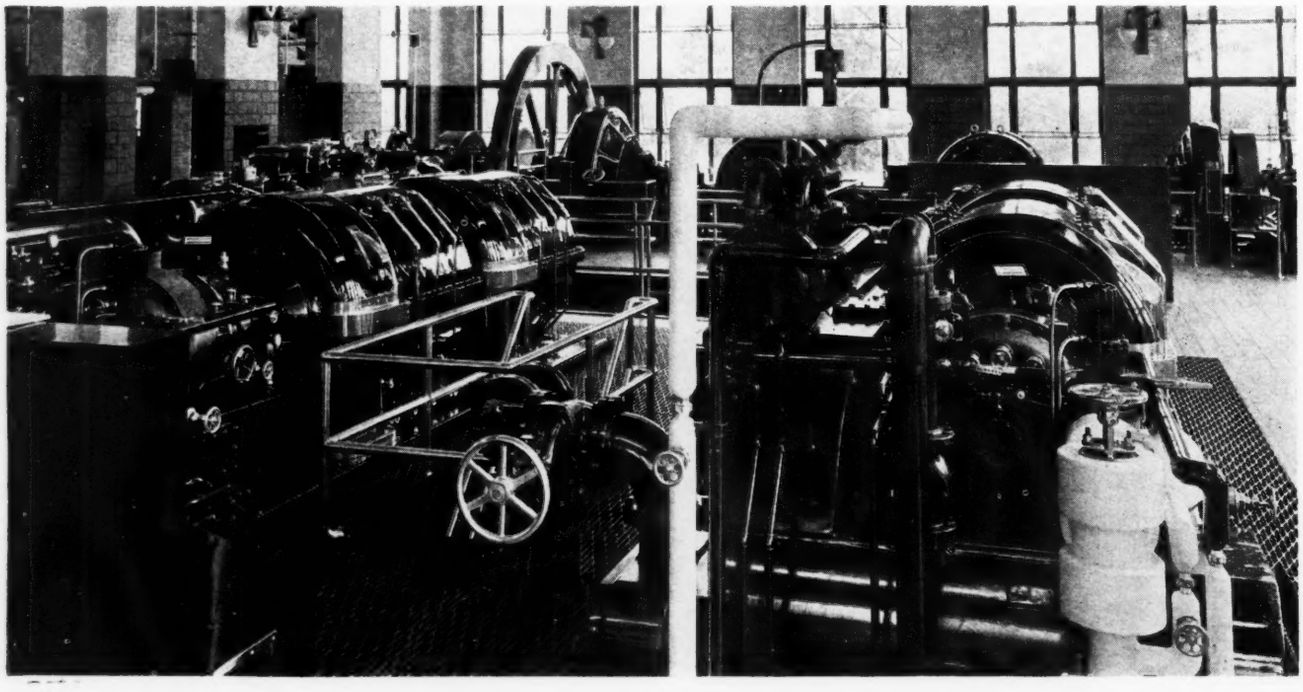
11,100 lb of steam per hr at 150 lb g (for turbine drive on compressors), 274 hp, or 204 kw (for motor drive on fans).

Transferred into dollars and cents, total operating cost becomes:

$$\begin{aligned} 11{,}100 \times \$0.0003 &= \$3.33 \\ 204 \times 0.02 &= 4.08 \\ &\$7.38 \text{ per hr.} \end{aligned}$$

Approximately 630 tons of refrigeration are required to cool the entire building, including the office section as well as dining rooms and some offices in an adjacent building. Then, \$7.38 ÷ 630 tons = \$0.0117 per ton per hr, practically one cent per ton per hr. This is a very low rate compared to costs in some installations of 3 cents or more per ton per hr.

Fig. 5 — Turbine or drive ends of the two centrifugal compressors



Look Over Your Present Plant First

Before spending too much time in wishful thinking about how much coal you could save if the Boss had money enough for a new boiler, take time out to see if the old plant is doing all it should

By C. A. Van Deursen
Western Public Service Co., Scottsbluff, Neb.

IN ALMOST every number of a power-plant magazine, we read headlines like these: "Stoker Installation Saves $...." or "Modernization of Boiler Plant Reduces Fuel Bill." And the figures given substantiate the claims. Of course they do.

Prior to making changes involving new equipment, ask yourself the question, "What is the maximum economy I can get from my old boilers and equipment if I spend a relatively small amount of money and time to bring them up to par?" Then, armed with a knowledge of what the plant could do, base the possible saving from modernizing on how much better the new plant will do than the old one at its best.

It doesn't seem fair to the old faithful "kettle" that has "put out" for many years, now scaled and full of air leaks, with short-circuited gas paths and impaired draft, to be condemned to the junk pile all because the man in charge has neglected his duty and let the plant get into a condition where almost any change will produce economies. Just duplicating the present equipment in many smaller plants would save perhaps 20 to 40% of the fuel cost because the new equipment would be in good operating condition.

Let's take down our back hair someday when the Boss is away (then we won't have to brush up the alibis), and put these questions on the table:

1. When did you last check the setting, and boiler in general, for air leaks? Remember that unnecessary excess air passes through the furnace, doing no good and certainly lots of harm to efficiency. And when I talk about checking for air leaks I mean with a candle and keen observation.

2. Do your dampers close tightly and operate freely? I remember a particular boiler with a damper that would not close more than halfway and fire was kept banked most of the time. Anyone can guess the results of that situation.

3. Do your baffles leak? Sure it's a dirty job, but a real improvement will show in economy.

4. How about the tubes? Are they clean? I recall being told of a boiler that never had to be cleaned, except for the drum. The feedwater was treated. Well, there may be some boilers like this, but not in the locality where this one is. At any rate, the boiler was taken out of service and several handhole caps removed. Was my face red when only the thinnest kind of a scale showed up! Here is the joke though: the same tube caps were removed every time the boiler was inspected. Removal of other caps showed some tubes completely plugged and others nearly so. Seven barrels of scale and mud were carried away before the cleaning job was done. The boiler is now doing better.

5. When was the last CO_2 test taken? In most small plants it is likely to be a year or more between tests. One hand-fired boiler that came to my attention ran 1 to 5% CO_2 before overhauling. An average of 3% CO_2 means a fuel loss of 46%. After repairs were made, the CO_2 was brought up to 10%, about 6% fuel loss, which isn't the best that can be done but is certainly a lot better.

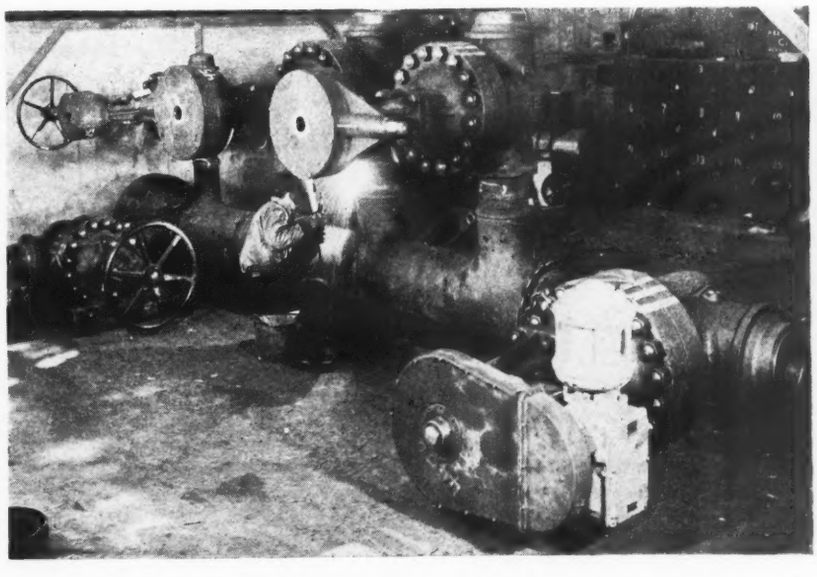
After good operating conditions are once established, draft gages and pyrometers are a reminder when things begin to slip again. When you've really begun to save some money without having spent much, you will be about ready to sit down and talk over that stoker or some other modernizing that has to go to the "higher ups" for an OK. The old boiler plant won't look quite so bad either. And remember, it will be a year or more before the new stoker starts to save anything; what you do to improve present operation starts to save money right now.

16-Ton Header Welded in Shop

This cast "carbon-moly" high-pressure steam header for 1200-lb., 900-F service has been delivered to Fisk Station of the Commonwealth Edison Co., Chicago. Header, branches and valves have been welded into a single assembly in the Crane Co. shops. Completed, the header weighs 32,265 lb.

The 14-in. header has a 14-in. valve welded to one end and a flanged-ring joint at the other. Four branches, two 10 in., one 8 in. and one 6 in., all have valves welded on. Several similar assemblies have been furnished by Crane Co. for boiler-feedwater service at Fisk, main steam, boiler-feedwater and reheat lines at State Line and for main steam and boiler-feedwater service at Des Moines City Railway station. Sizes range up to 24 in.

Fabrication of complicated sections in the shop reduces to a minimum the time required for field welding. While many shop welds are "position welds," the entire assembly can be shifted or rolled to avoid cramped welding conditions. All welding is done by qualified operators under the inspection of the Hartford Steam Boiler Inspection & Insurance Co.



No More Water Trouble

Mechanically agitated coagulation, filtration and zeolite softening keep boilers scale-free at the Gulf Oil plant, Port Arthur, Texas

By H. R. Sharpless and S. B. Applebaum

Supt. of Power, Gulf Oil Corporation — *Vice-President, The Permutit Co.*

THE REFINERY of the Gulf Oil Corporation at Port Arthur, Texas, draws its water from the Neches River. General character of the supply is:

	ppm
Total hardness as $CaCO_3$	45-60
Ca ..... as $CaCO_3$	21-25
Mg ..... as $CaCO_3$	24-35
M. O. Alk... as $CaCO_3$	24-28
Phenol " as $CaCO_3$	0-0
Free CO_2.... as CO_2	2-6
Chlorides ... as Cl	85-130
Sulphates ... as SO_3	70-100
Silica ..... as SiO_2	10-20
Total Solids	205-334

It is a fairly soft water, high in turbidity and color, yet gave considerable trouble in the boilers because of the high percentage of makeup (72-85%). Composition varies slightly with the season, consequently a large reservoir is used to permit drawing water low in chlorides.

Prior to 1929, water was batch-treated in six settling tanks, 55 ft in diameter and 35 ft high. Various coagulants and softening reagents were employed, but a hard calcium sulphate scale, and later a silicate scale, formed.

When high-pressure boilers were installed in one of the four boiler houses in 1929, Cyrus William Rice & Co, consulting chemists, investigated the water-treatment problem. As a result, a complete Permutit coagulation, filtration and zeolite-softening plant with a capacity of 5,000,000 gal. per day was installed to remove turbidity, color, organic matter and hardness. Boiler pressure in one of the other boiler houses has since been increased to 725 lb, in waterwall units operating at 400% rating.

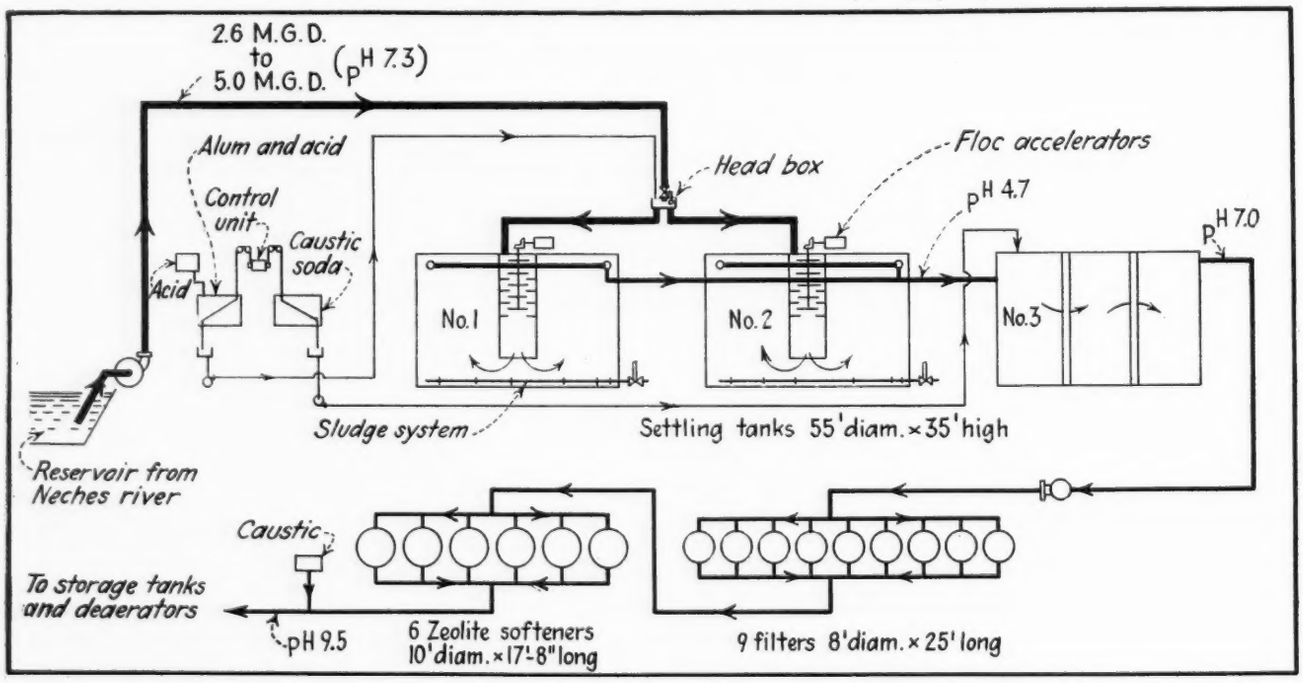
The new treatment plant was designed so that various chemicals might be used for coagulation of the finely divided and hard-to-coagulate turbidity in the water. The chemical feeders are capable of supplying lime, alum, soda ash, iron sulphate, and CO_2. Phosphate may be added to maintain soluble PO_4 concentration in boiler drums, setting up a second line of defense against residual hardness.

A combination of alum, sulphuric acid and caustic soda proved to be the best and most economical treatment. Apparently a low pH value is required for optimum coagulation of the turbidity and color of this water. About 2 to 3 grains per gal. of alum sulphate plus about a grain of sulphuric acid are added to produce an alum hydrate floc.

General Arrangement

General arrangement of the plant is illustrated in the simplified flow diagram, Fig. 1. The alum and acid mixture is pumped to the head box which maintains fairly constant flow from the reservoir to the two settling tanks arranged for parallel operation. The addition of caustic soda in the third tank raises the pH value to about 7. The water is then filtered through nine sand filters and softened in six zeolite softeners, shown in Fig. 2. Treated water is stored in three of the original six settling tanks. Another dose of caustic soda raises the pH to 9.5, to protect an extensive distribution system and establish proper alkalinity for boiler concentrates.

Fig. 1—General arrangement of coagulation, filtration and softening equipment



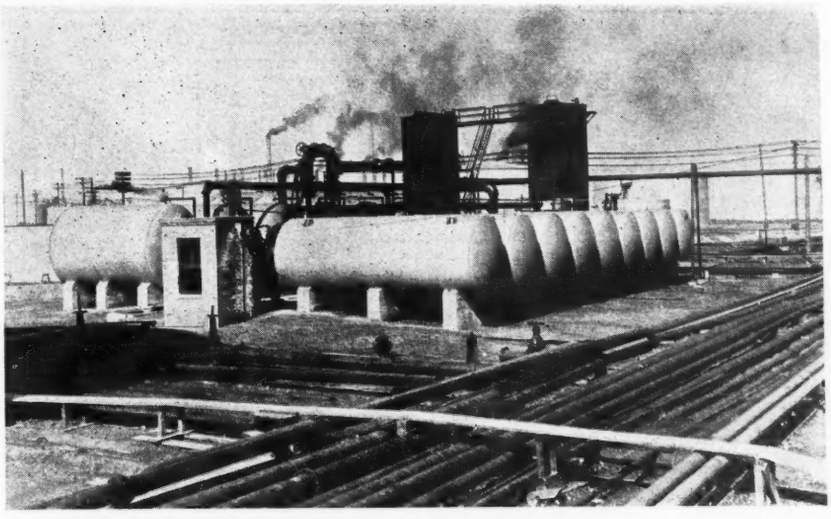


Fig. 2—Filters and softeners

TABLE I
Amounts of Chemicals Used

Alum Sulphate	40 ppm*
Sulphuric Acid	15 "
Caustic Soda	35 "
Sodium Chloride	235 "
Phosphate	12 "
Sodium Sulphite	3 "

** Or lb chemical per million lb water*

TABLE III
Typical Chemical Results in Boilers

Total Hardness as $CaCO_3$	0 ppm
M. O. Alkalinity " "	330 "
Phenol " "	270 "
Chlorides " Na Cl	1000 "
Sulphates " Na_2SO_4	1000 "
Total Solids	2330 "
Sulphate-carbonate ratio	3 "
pH value	11.5 "
PO_4	40–60 "
Sodium Sulphite	30–60 "

TABLE II
Typical Chemical Results at Various Stages of Treatment

	Raw	*From Tanks 1 & 2*	*From Filters*	*From Softeners*	*To Heaters*
Total Hardness as $CaCO_3$	50 ppm	50 ppm	50 ppm	0 ppm	0 ppm
M. O. Alkalinity " "	26 "	–7 "	18 "	18 "	40 "
Free CO_2 " CO_2	2 "	25 "	2 "	2 "	0 "
Chlorides " NaCl	110 "	110 "	110 "	110 "	110 "
Sulphates " Na_2SO_4	85 "	120 "	120 "	120 "	120 "
Total Solids	220 "	250 "	270 "	270 "	290 "
Sulphate-carbonate ratio	.... "	.... "	.... "	6.7 "	3 0 "
pH value	7.3 "	4.5 "	7.6 "	7.6 "	9.5 "

Phosphate is added at the various boiler houses.

Agitation Forms Proper Floc

Mechanical agitators for accelerating floc formation shorten settling time as does parallel arrangement of the first two settling tanks. The floc acceleration device consists of a motor, speed reducer, vertical shaft, and rotor agitators operating between stationary blades. Agitation introduces sufficient energy into the water to whip the floc into a tough, large-particled, quickly-formed precipitate which settles rapidly. Parallel operation of the first two settling tanks, instead of the original series arrangement, produced faster settling by reducing velocity. The change to parallel operation also proved the value of mechanical agitation, since at the time of the change only one tank (No. 1) was so equipped. The contrast in appearance of settled water from tanks Nos 1 and 2 was sufficient evidence to warrant installing floc-acceleration equipment on tank No. 2. The value of floc acceleration is demonstrated graphically in Fig. 3.

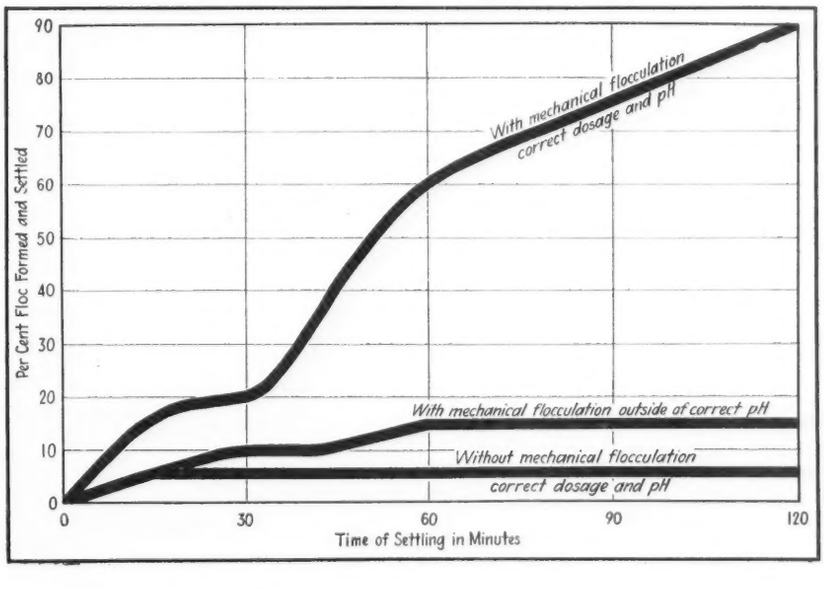
Attention to design of settling tanks also aided in achieving good coagulation. Care in baffling avoided short-circuiting and localized high velocities, as well as sludge pickup and carryover. Central downcomers are employed in which the agitation devices are located and water is collected uniformly, at the top, by means of a perforated drawoff collector.

Chemical feeds are of the ground-operated type. Solutions of alum and acid are prepared in one tank, caustic soda in another. The mixture of alum and acid joins incoming raw water in the head box, and dosed water divides evenly between the two parallel settling tanks. Caustic is pumped into the third tank. Feeding of chemical is made proportional to the flow of raw water by a control unit which regulates the rate of lowering of the swing pipes in the solution tanks.

Precipitates formed by the alum-acid solution settle out in the bottom of tanks Nos 1 and 2 and are periodically removed by the sludge system in the bottom of these tanks. A series of perforated pipes is connected into headers leading to quick-opening valves so that a section of each system can be operated at a time. Sludge is discharged into a sump from which decanted water is recovered and pumped back to the head box.

Boilers are blown down continuously and the heat recovered in heat exchangers, as shown in the flow diagram for the boiler system, Fig. 4. Blowdown water under boiler pressure passes directly through the heat

Fig. 3—Effect of mechanical flocculation on settling



exchangers into rate-of-flow controllers, one for each boiler. Thus the rate of flow from each boiler can be individually regulated to insure correct blowdown.

Results of Operation

The use of acid together with the more expensive alum has saved alum. It was found that without acid, as much as 3 to 5 grains of alum per gal. of water were required to obtain good floc formation. With acid, the dose was cut to 2-3 grains per gal. The large amount of alum originally used was due not only to the necessity of making considerable floc to coagulate the high turbidity but to the necessity of obtaining a low pH value for optimum coagulation of the floc. A pH below 5 gave the best results. The fact that one grain of acid is as effective in reducing pH as 2 grains of alum makes possible large economies in a plant of this size. The amounts of the various chemicals used are given in Table I, and the results of treatment at various stages are in Table II.

Relieving filters and softeners of an unnecessary burden is an important effect of good coagulation. If pretreatment is improperly carried out and coagulation is imperfect, so that the settled water contains smoky floc, that is, floc in a colloidal dispersed form, the sand grains in the filter bed tend to get coated. This results in mudballs of sand grains matted together, shrinkage cracks and other well-known filter troubles. Good coagulation means clearer settled water, consequently filters run longer between backwashings and require less frequent attention. The filters in this plant are backwashed with filtered water and a considerable proportion of the wash water is recovered and reemployed.

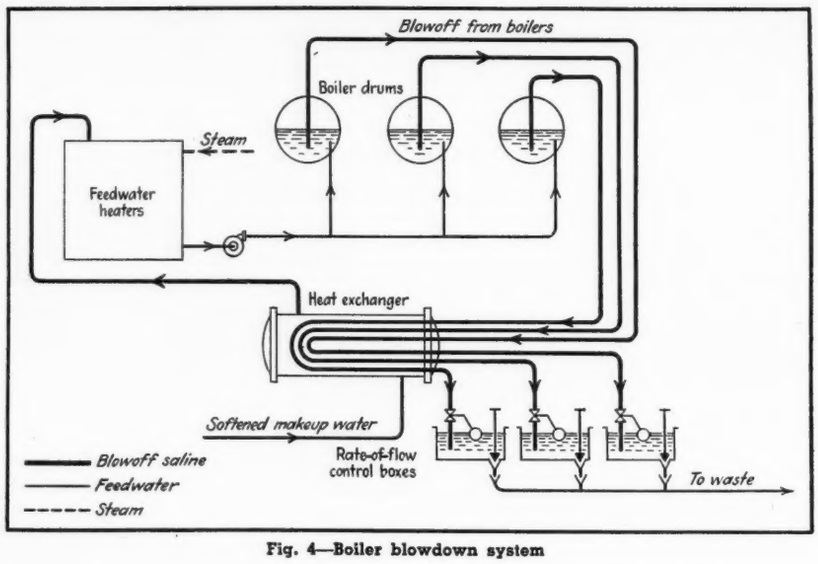


Fig. 4—Boiler blowdown system

The zeolite, Permutit "Zeo-Dur," is of the glauconite type and has given satisfactory performance. The amount of zeolite replacement required in the eight years of plant operation constitutes a little more than 1% per annum, extremely low considering the type of raw water involved.

The continuous blowdown system has maintained uniform concentrations of dissolved solids, thereby promoting formation of best-quality steam and avoiding foaming and carryover frequently resulting from high concentrations, especially at high loads.

As Table III indicates, the sulphate-carbonate ratio required for inhibition of embrittlement is maintained in the various boilers, and a phosphate concentration of about 40-60 ppm takes care of any residual hardness in the feed. Recently sulphite has been added as a secondary precaution against oxygen corrosion, serving to back-up the deaerating heaters, which have been steadily improved. Sodium sulphite is added after the deaerating heaters and in such quantities as to produce a 30-60 ppm concentration in the boilers.

Exhaust Lines

By E. J. Tangerman

The movies are using more and more power for lighting. In "Vogues of 1938," several scenes required lighting loads of 15,000 amp, supplying almost 4,000,000 cp. Single lights, giant 36-in. "sun-acres," supply 95,000 cp. The advent of Technicolor doubles the amount of illumination required, so that the old Kleigs and Cooper-Hewitts, supplanted by noiseless incandescents when sound movies came in, are coming back in refined versions.

Leading Swedish electrical engineers are constructing a 621-mile transmission line to bring power from northern waterpower sites to more populated districts. The next step is to bring power from Lapland, over 900 miles away, using aluminum conductors. Over 50% of Swedish farm areas are electrified.

Various insurance companies are backing a movement to reduce welding fires, which may be caused by globules of hot metal at distances of 35 ft or more from the welder or cutter. Fires are 45% more frequent this year than last, 64% ahead of 1935. Eventual result will probably be inspection of welding areas and allowing work only under signed permit in designated areas by experienced operators. All combustible material will be removed first, then floors swept and wet down, or wood floors covered with steel. Asbestos curtains may also prove effective. The rules will require watching the area for ½ hr after welding and use of sprinkler systems and fire extinguishers.

An internal-combustion engine with no valves of the conventional type has been developed by F. M. Aspin of Bury, Lancashire, England. Its weight is one-third that of the average engine of the same horsepower. Gasoline consumption is reduced one-half.

Every once in a while, a power engineer changes his job and his title. John Tiebor went to work in the Tonawanda, N. Y., waterworks when he was 14, back in 1873, right after he came to this country from Germany. Along about 1904, he got interested in California sea lions, the "trained seals" of circuses, and decided to buy one. Over his wife's objections, he did. After some training, he got four more, then quit being a stationary engineer and was booked as "Captain Tiebor" on vaudeville, with his first booking in Pittsburgh in the winter of 1905. He's been at it ever since, and now has two of his four sons helping him.

Italy is going to high-speed elevators. Monccantini Co. is installing 20 high-speed Westinghouse units in its 15-story office building in Milan.

Sweden's production of electric power during the last three years showed an average annual increase of 690,000,000 kwhr, against a previous normal annual increase of 200,000,000 kwhr. During the same period, average yearly power obtained through new waterpower construction was 60,000 kwhr against 45,000 kwhr earlier.

Prevention of Freezing in Elevated Tanks

A study of local weather records and a heating device, either a coil, mixing valve or the indirect type, depending on the tank and the purpose it serves, provide an anti-freezing combination

By Charles L. Hubbard

ELEVATED TANKS, either for general water supply or fire service, frequently form part of the equipment of industrial establishments and institutions having their own power plant. As much depends upon their ability to supply water under pressure at an instant's notice, the matter of freezing is an important one.

It is stated, in a general way, that tanks located south of 43 deg latitude and used for purposes where the water changes frequently, will not require special provision against freezing, except for insulation of connecting pipes. This line passes through southern Oregon, south-central Michigan, central New York and southern New Hampshire.

Wide Variations

This statement can be accepted only in a very general way because there are wide variations in both temperature and wind velocity in different locations at the same latitude. While high winds tend to increase rate of cooling, lower temperatures usually occur without wind, although in the lake regions and other localities high winds and low temperatures are concurrent. In view of these variations, local weather records should always be consulted, and the degree of latitude used for rough approximations only. When the tank is a source of supply for a sprinkler system and there is no movement of water, there is much greater possibility of freezing, and added precautions must be taken.

Under average winter conditions when a tank is exposed to the sun, water will stand at about 40 F and must therefore be cooled 8 F before it reaches the freezing point.

In still air, heat will pass from water to air at the rate of about 1.5 Btu per sq ft of surface per hr per deg F difference in temperature between the surrounding air and the water, for steel tanks. This figure is for the shell and bottom. As the top has a cover and air space, take one-half the above rate of heat flow for this area. For a wooden tank, with staves 2½ to 3 in. in thickness, use a transmission factor of 0.4 Btu. In making computations for rate of cooling, assume an *average* water temperature of

$$\frac{40 + 32}{2} = 36 \text{ F}$$

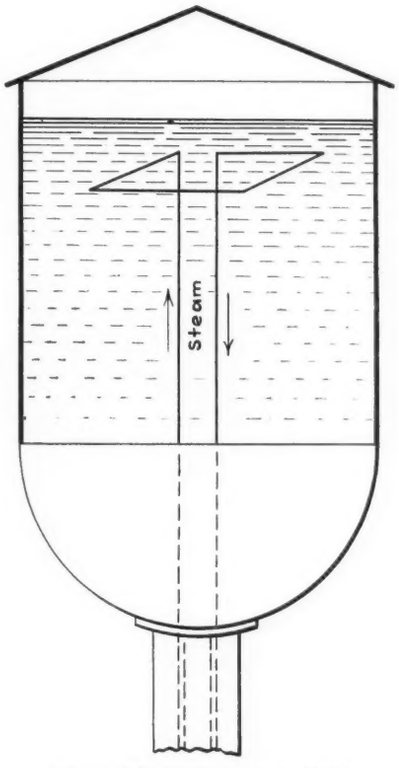


Fig. 1—Where steam is available, a coil provides a simple solution

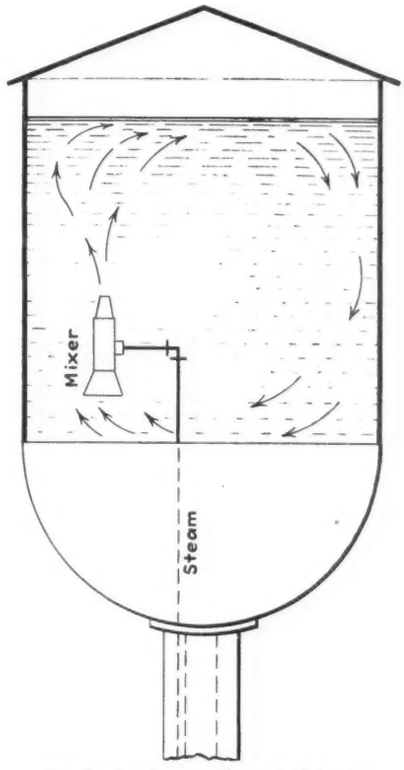


Fig. 2—Another simple method for preventing freezing—a mixing valve for blowing steam directly into the water

To cool one lb of water from 40 to 32 F and freeze it into ice at the same temperature, requires the abstraction of 8 + 143 = 151 Btu, or 151 × 57.5 = 8,683 Btu per cu ft of ice.

With this data at hand, it is a simple matter to compute the approximate length of time required for ice to form at any given thickness over the inside and top of a tank for different outside temperatures.

Example

For example, a steel tank 15 ft deep and 10 ft in diameter is exposed to an outside temperature of 0 F. Using factors and assumptions previous'y given, the length of time it will take for a coating of ice 3 in. thick to form over the inside and top surface is shown in the following table:

Area of top surface	78
Area of shell	471
Area of spherical bottom	314
Total exposed surface, sq ft	863
Cu ft of ice to be formed	863x0.25 = 216
Btu's abstracted to cool one lb of water from 40 F and form ice at 32 F	151
Weight in lb of one cu ft of ice at 32 F	57.5
Btu's abstracted to form 216 cu ft of ice	216x8,683 = 1,875,528
Diff. in temp. between air and water, F	36
Btu loss per hr from surface	36x0.75x78 = 2,106
Btu loss per hr from shell	36x1.5x471 = 25,434
Btu loss per hr from bottom	36x1.5x314 = 16,956
Total Btu loss per hr	44,496
Time to produce 216 cu ft of ice	1,875,528 ÷ 44,496 = 42 hr

In case of a wooden tank the length

of time required would be nearly four times 42, or 168 hr.

As a matter of fact, actual time would be somewhat greater than computed, because the ice coating acts as an insulator which tends to reduce rate of heat transmission, and also the heat of the sun on the outside of the tank has a similar effect when the sky is clear, usually the case in very cold weather. Furthermore, extremely low temperatures hardly ever hold continuously for any great length of time, and the water temperature gradually rises above the freezing point, so that ice does not accumulate sufficiently upon sides and bottom of the tank to interfere with its operation under ordinary winter conditions. However, surface ice is more objectionable, as it exerts a strong outward pressure, due to expansion, which may injure the tank when the layer becomes thick enough. Also, it interferes with the action of floats and ballcocks, closes overflow pipes, and in general is not desirable, particularly where the tank is used for sprinkler service, and is in an exposed location. In cases of this kind, it is customary to provide means for warming the water temporarily during cold spells of any considerable length.

Tank on Building

When the tank is supported upon a building or located near a plant where steam is available, a coil, shown in Fig. 1, offers one of the simplest solutions. As freezing first takes place near the surface, a coil located at the top of the tank is fully as effective for quick action, although one at the bottom will answer equally well if the entire body of water is to be warmed to a uniform temperature.

While steam may be kept on the coil for any length of time, it is more customary to make it of such size that by turning on steam for a couple of hours or so, freezing will be prevented for 24 hours. In the tank under consideration, heat loss in zero weather was found to be $44{,}496 \times 24 = 1{,}067{,}904$ Btu per 24 hr.

A brass coil supplied with steam at 5 lb pressure will transmit approximately 48,000 Btu per sq ft of surface per hr to the water of the tank, assuming the latter to have an average temperature of 36 F. If it is desired to prevent freezing for 24 hours by operating the coil two hours, then $1{,}067{,}904 \div 2 = 533{,}952$ Btu to be given off per hr by the coil, which calls for $533{,}952 \div 48{,}000 = 11$ sq ft of heating surface, or $11 \times 2.3 = 25.3$ linear feet of $1\frac{1}{4}$-in. pipe.

Brass pipe is more desirable for heating coils than galvanized iron but if for any reason the latter is used, the surface for brass should be multiplied by 1.7. If different ratios are desired between time of coil operation and provision against freezing, factors in the computation may be changed accordingly. If the steam is free from oil and the water is used only for industrial purposes or sprinkler service, steam may be blown directly into the water through a mixing nozzle, Fig. 2.

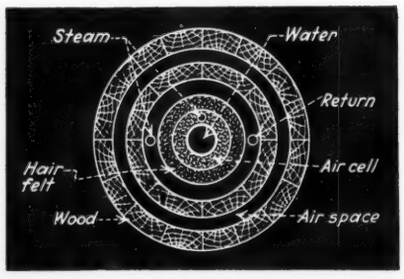


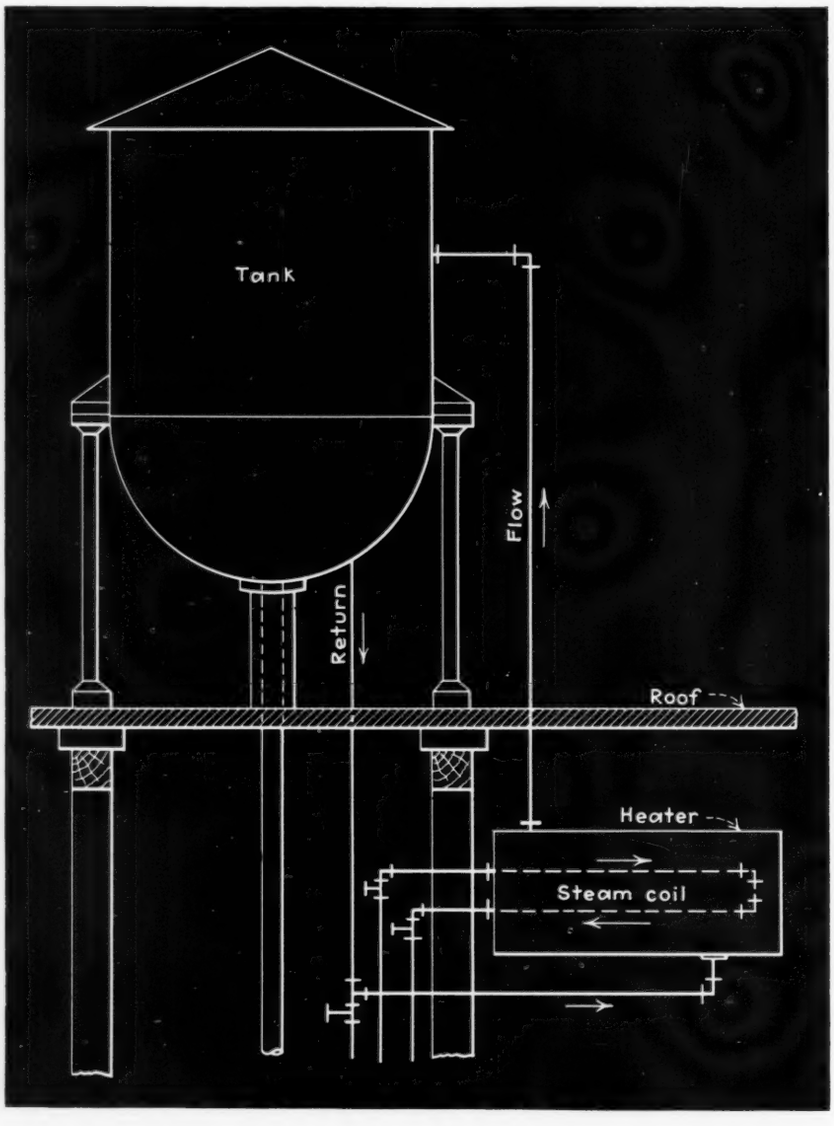
Fig. 4—A typical insulation arrangement for heating pipes leading to a tank

Heating

When tanks are located above the roof of a building, the indirect method of heating is sometimes used, Fig. 3. In this arrangement the coil and its connections are easily accessible for inspection and repair. To compute the coil surface for other steam pressures, allow a transmission efficiency of 250 Btu per sq ft of coil surface per hr per deg F difference between steam and water for brass pipe, and 150 for iron. As brass pipe is preferable in every way, and the amount required is comparatively small, its use is recommended for all work of this kind.

Another important detail to be considered is the insulation of pipes leading to the tank. A typical arrangement for this purpose is shown in Fig. 4. The small pipe shown directly against the main riser is connected with steam pressure at the bottom and left open at the top. It is used for thawing out the riser in case of a freeze-up.

Fig. 3—For tanks above building roofs, the indirect heating method provides easy accessibility for repair and inspection



Turbo Gas Exhauster Holds Constant Suction

By John Avery
Asst. Manager,
Blower and Compressor Department,
Allis-Chalmers Mfg Co

A 650-hp, 5,100-rpm non-condensing, steam-turbine-driven turbo gas exhauster has its suction automatically controlled by regulating turbine speed. Here is a detailed description of the operation of the regulator

EXHAUSTING GASES from by-product coke-ovens is a common application for turbo-blowers. Such ovens are used extensively to produce large quantities of coke for blast-furnaces, water-gas manufacture and various other purposes. During coking, to obtain maximum yield of byproducts as well as highest-quality gas, it is necessary that the gas be drawn off at a uniform rate. This is done by an exhauster provided with automatic control to maintain a constant pressure in the ovens, or in the gas-collector main leading from the ovens.

The exhauster may be a positive-pressure or turbo type, either motor or steam driven. Steam-turbine-driven turbo-exhausters are frequently used for this purpose, speed control of the turbine being employed to maintain constant pressure in the ovens. Because of their relatively larger internal clearances, turbo-exhausters are less susceptible to trouble from tar than other types, and the centrifugal action of their impeller wheels acts to some extent as a supplementary tar extractor.

On its way to the exhauster, gas is cooled to a temperature in the neighborhood of 75 to 120 F. Water sprayed into the gas system saturates the gas before it enters the exhauster, which makes it necessary to design the exhauster large enough to handle the water vapor as well as the gas.

As a rule, the exhauster must develop a suction of from a few inches of water to minus 0.5 lb per sq in. or more, and a discharge pressure up to around 5 lb. The latter is necessary to force the gas through the various apparatus in which it is further cleaned and byproducts recovered. Because coke-oven gas is very light (its specific gravity, referred to air, usually ranges from 0.32 to 0.45), more impellers are required in a turbo-exhauster than are necessary for an equal pressure with air.

Fig. 1 shows a steam-turbine-driven turbo-exhauster, designed to handle 2,700,000 cu ft of dry coke-oven gas per 24 hr (18,750 cu ft per min), creating a suction of 0.5 lb per sq in. and discharging at 5 lb g. Specific gravity of the gas ranges from 0.36 to 0.39, and inlet temperature is 90 F maximum. At 90 F and minus 0.5 lb per sq in., this volume of dry gas is equivalent to 22,050 cfm of saturated gas, the rated ca-

Fig. 1—Coke-oven-gas exhauster driven by a 650-hp, 5,100-rpm non-condensing turbine

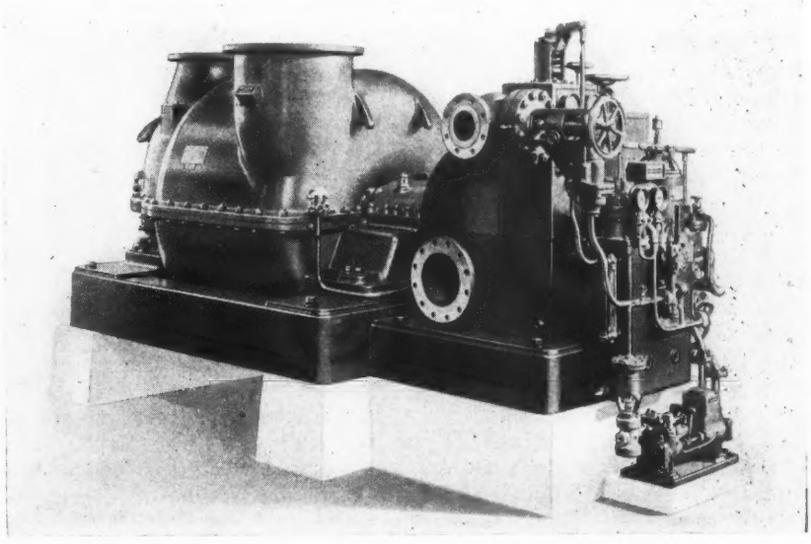
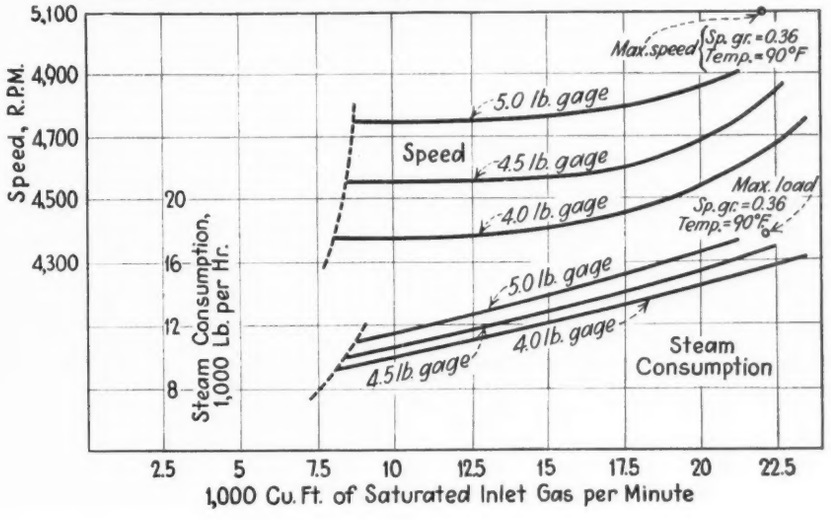


Fig. 2—Expected speed and steam-consumption curves for the turbine-driven gas exhauster of Fig. 1, based on saturated gas at 77 F and 14.2 lb per sq in. abs suction pressure. Specific gravity dry gas 0.39



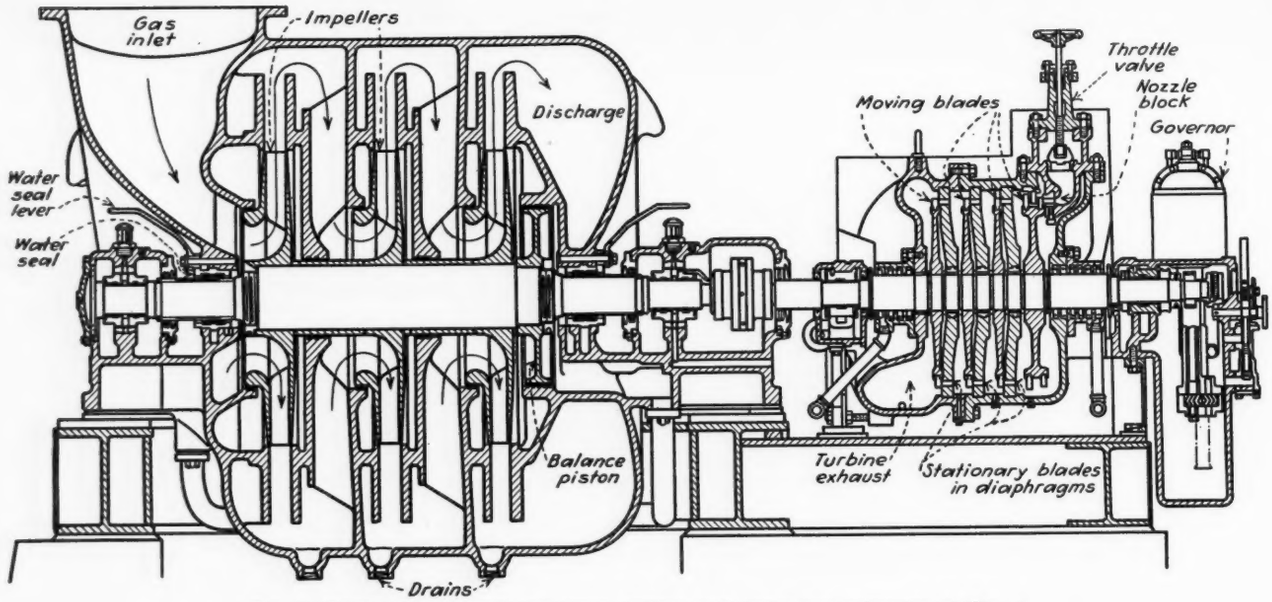


Fig. 3—Cross-section through the steam turbine and turbo gas exhauster of Fig. 1

pacity of the unit. Fig. 2 shows the characteristics of the exhauster, which is designed for a maximum speed of 5,100 rpm, and is driven by a 650-hp non-condensing steam turbine.

The exhauster is a 3-stage turboblower of standard design, modified to handle gas by including tar-drain connections at the lowest points in each stage and water-sealed glands where the shaft emerges from the casing, to prevent the entrance of air. During operation, collars on the shaft throw the water out to form the seal. When the unit is stopped, the water is shut off, and the whole gland is moved axially by a lever to form a tight mechanical seal. Should the operator fail to slack off glands before starting again, no harm will result, as gland faces are babbitt.

In operation, a centrifugal exhauster is not affected by tar. The heat of compression keeps the tar liquid, and it is thrown out to the casing walls, from which it works downward to the lowest points and can be drained. When an exhauster remains idle for some time, tar will cake on the wheels and clog the glands, causing difficulty when the unit is again started, unless precautions are taken. To avoid this difficulty, turbo-exhausters may be provided with a nozzle for spraying light oil into the first impeller for several minutes before shutting down. The light oil tends to keep the tar solvent.

In Fig. 4, the exhauster is shown with the upper half of the casing and diaphragms removed to expose the three impeller wheels, which are of backward-curved-blade, enclosed design. The rotating element comprises three impellers and balance piston mounted on the shaft.

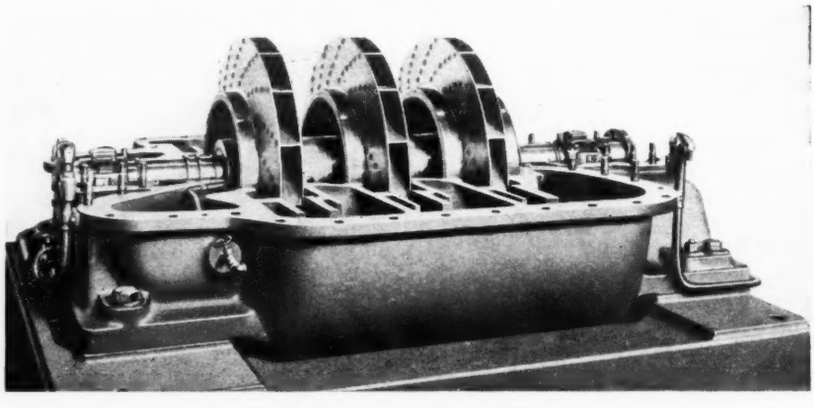
The multi-stage impulse steam turbine, Fig. 3, has a 2-row Curtis element followed by three Rateau wheels. It is designed to develop a maximum of 650 hp at 5,100 rpm when supplied with steam at 175 lb g and 100 F superheat and when exhausting against 17-lb g backpressure. Hand valves controlling auxiliary nozzles are provided to permit developing full power with steam at 140 lb gage and 100 F superheat and 25-lb g backpressure.

Governing Equipment

Included in the turbine equipment is an oil-operated trip throttle valve, connected to the emergency overspeed-trip governor, a complete lubrication system for it and the exhauster including a main oil pump driven from the turbine shaft, an oil cooler, oil reservoir and an auxiliary steam-driven reciprocating oil pump with automatic governor. The latter is so arranged that the auxiliary pump will run whenever oil pressure from the main pump is not sufficient, as for instance, when starting up, shutting down, or in case of any failure of the main pump. Other equipment includes a variable-speed oil-relay governor; a mechanical pre-emergency governor; a vibrating tachometer and necessary steam and oil gages. Fig. 1 shows the steam end with the various governing and auxiliary equipment.

A Shalleross exhauster control regulates speed to maintain constant suction. Fig. 5 shows how it is connected into the turbine governing system. It comprises a small reversing motor controlled by suction, which operates a regulating valve in the oil line leading to the sylphon bellows of the variable-speed governor. Oil pressure on the bellows depends upon amount of oil allowed to flow through the regulating valve by the exhauster control. Position of the bellows in turn controls the oil-relay position which actuates the turbine governor valve. The mechanical flyball speed governor driven from the turbine shaft is so arranged that it will not influence oil-relay position until speed reaches a maximum allow-

Fig. 4—Lower half of the gas exhauster, Fig. 1, with rotor in place



able value of 5,100 rpm. At that speed the governor will nullify any attempt of the exhauster control to increase speed further.

Referring to Fig. 5, the gear oil pump discharges into a header, one branch of which goes to the oil cooler and the bearings and another to the relay cylinder. A third path is through an adjustable orifice into the chamber surrounding the sylphon bellows. Oil pressure on the sylphon bellows is regulated by the valve under control of the exhauster control. An increase in suction causes the control to reduce its valve opening, and a decrease in suction tends to increase its valve opening.

Suction Increase

Assume an increase in the suction. The control will then reduce valve opening, and oil must flow at a slower rate from the sylphon-bellows chamber. Because of restriction in oil flow, pressure in the chamber will rise and compress the sylphon upward against tension of spring S and through the movement of levers L and L_1 the pilot valve moves downward in the relay cylinder. The relay valve admits pressure oil above the relay-cylinder piston connected to lever L_2, and its downward movement reduces the throttle valve opening to slow down the turbine. When the relay-cylinder piston moves down a distance equal to the pilot-valve movement it closes the ports of the latter and stops further movement of the throttle valve.

With a decrease in suction, the control opens the valve in the oil line to reduce pressure on the sylphon and opens the throttle valve to speed up the turbine.

When speeding up the turbine, the sylphon raises the left-hand end of lever L_1. If the speed exceeds 5,100 rpm, the centrifugal governor comes into action and raises the right-hand end of lever L_1. In doing so it moves the left-hand end of this lever downward and tends to close the throttle valve and offset any effect of the exhauster control to raise turbine speed above 5,100 rpm. Opening and closing the hand-control valve on the sylphon chamber will have the same effect as opening or closing the exhauster-control valve.

For other applications, it is a simple matter to substitute for the exhauster control any other type of special regulator, such as constant-volume regulator, constant-pressure regulator, etc.

Units of the general type described above are suitable for gas boosting as well as exhausting, and are also used for circulating gases in chemical plants.

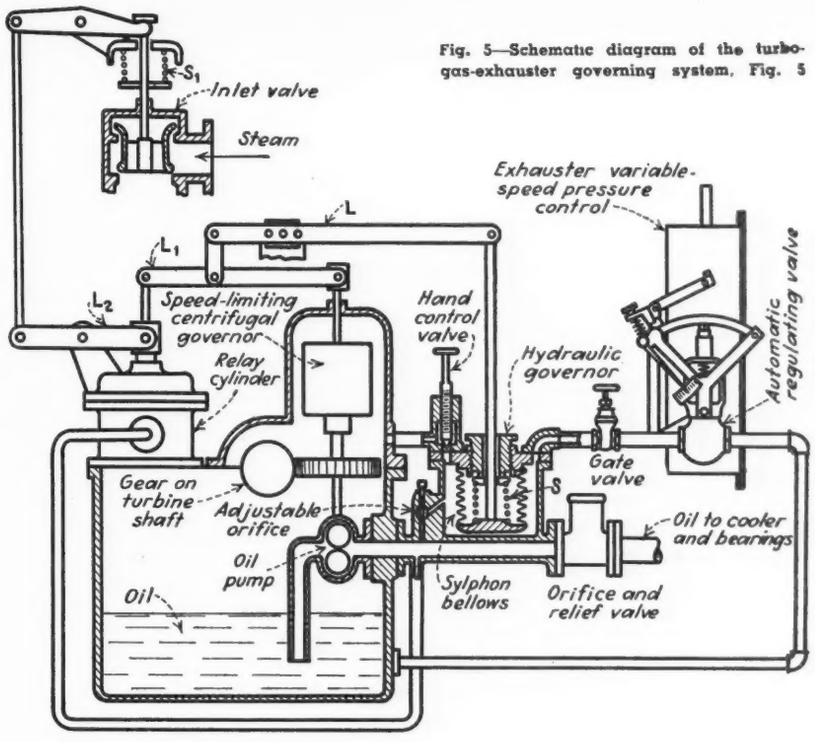
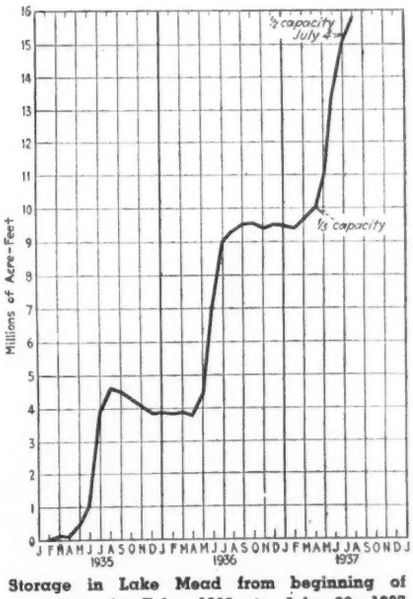


Fig. 5—Schematic diagram of the turbo-gas-exhauster governing system. Fig. 5

Storage in Lake Mead Above Boulder Dam

THE CURVE shows progress of water storage in Lake Mead above Boulder Dam. Storage began in February, 1935, and reached a maximum that year on July 31 of 4,578,000 acre-ft. In 1936, maximum storage accumulated to 9,640,000 acre-ft and on July 4 of this year the reservoir was half full. Storage continued to increase, reaching a maximum of 15,701,000 acre-ft on July 28. At that time the water had a maximum depth of 463 ft above the old stream bed level and the lake extended up the canyon 108 mi. At the rate of storage up to this time, it will require 3 more years to fill the reservoir to its capacity of 30,500,000 acre-ft. The droop in the 1935 curve is when, with only 5,000 sec-ft flowing into the reservoir a 10,000 sec-ft flow was maintained in the river below the dam during a drought, thus preventing a serious water shortage below the dam.

Power is now being generated by four 115,000-hp units. Two more units of this capacity are being installed and two were ordered recently. These, with a 55,000-hp unit now in place, will bring plant capacity to nearly 1,000,000 hp, the largest hydropower installation anywhere in the world. Space is provided in the plant for seven more 115,000-hp and one 55,000-hp units, a total capacity of 1,835,000 hp.



Storage in Lake Mead from beginning of operations in Feb., 1935, to July 28, 1937

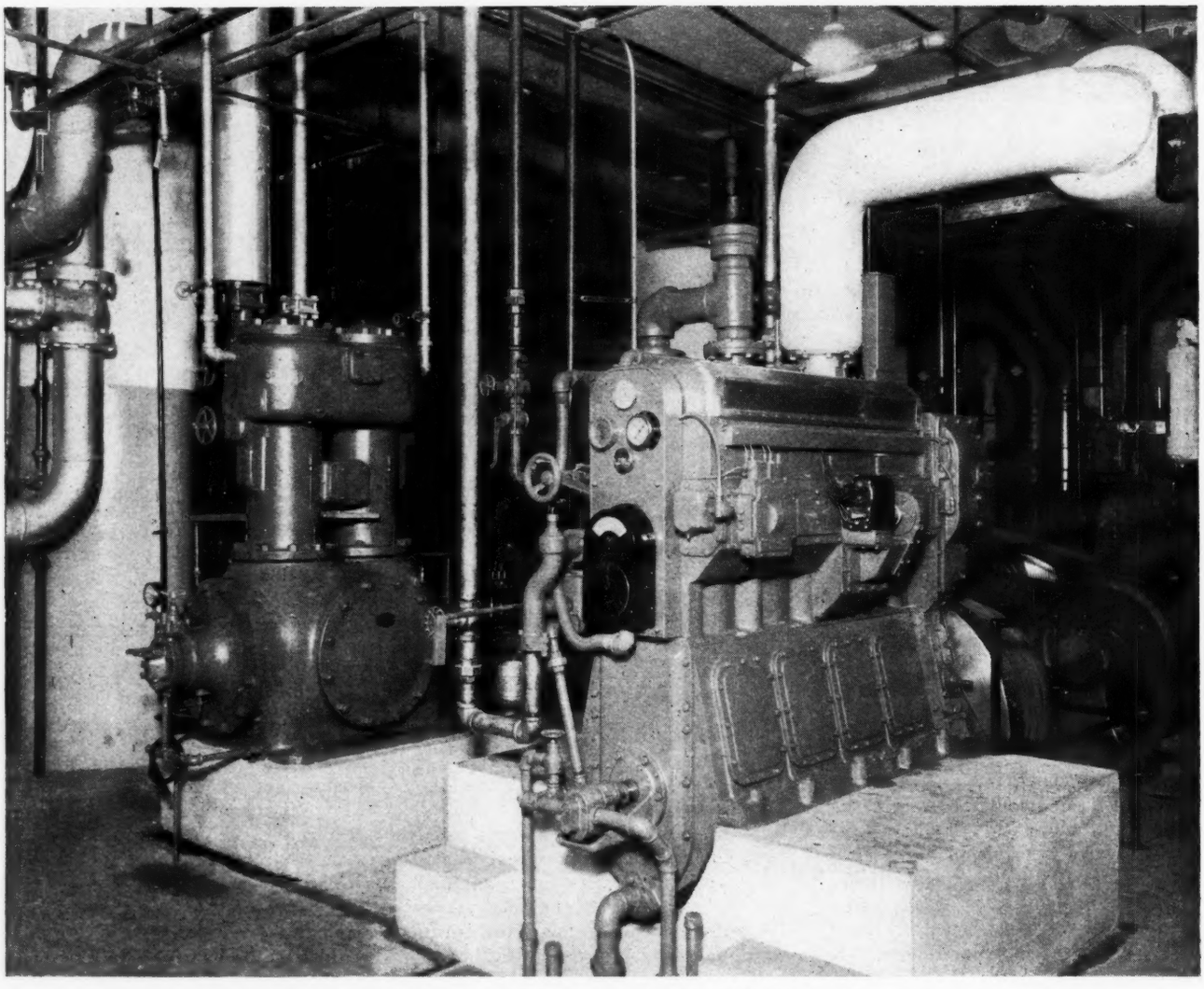


Fig. 1—One of the 110-hp gas engines belted to a 10x10-in. compressor

Sears Conditions With Gas

An ammonia plant, powered by gas engines, provides air-conditioning the year 'round at the Dallas plant. Ammonia is the refrigerant; a special "home-made" condenser-water cooler saved $10,000; and finned coils replace the usual air washer

By Orville Adams

AIR-CONDITIONED the year 'rourd, the Dallas plant of Sears Roebuck & Co., employing approximately 1,800 people, with as many as 250 sales people serving daily from 5,000 to 10,000 customers, is one of the most efficient and economically operated plants in this vast merchandising chain. The three retail floors are completely air-conditioned, with full temperature and humidity control. One of the 10 large plants air-conditioned last year by Sears, the layout has many features.

The 250-ton refrigeration plant and gas-engine power units are in the basement, in conjunction with the steam power plant for heating and power load during the winter. Part of the steam plant supplements the gas engines during the summer. A steam-engine refrigeration unit is employed for cooling drinking water. A compound steam engine and air compressor does air-lift water pumping from wells. The plant is completely self-contained, having facilities for furnishing its own water, heat, light, and air-conditioning.

The air-conditioning plant comprises a spray-type ammonia cooler, shell-and-tube condensers and 10x10-in. ammonia compressors, the compressors being multiple-V-belt-driven by Cooper Bessemer 120-hp gas engines. These 9x10½-in., 514 rpm. engines are convertible to diesel operation by changing fuel equipment, etc. Each engine is equipped with standard oil filters and coolers, air filters, silencers, and pyrometers. Reliance tachometers and Bosch magnetos are standard.

Engine speed is varied to suit load demand as determined by temperature requirements. The engines operate satisfactorily over a wide range speeds and loads, affording utmost flexibility in meeting the variation in

humidity and temperature control. Essential auxiliary and control equipment has been provided to safeguard operation as well as to control operation efficiently.

One of the features of the refrigerating plant is the special condenser water cooler conceived and designed by M. G. Harbula, consulting engineer for the entire project. It consists of a large fan from the old ventilating system, a specially designed 2-stage, spray-type air cooler with moisture eliminators, and necessary condenser-water pumps.

Efficient use was made of old coal vaults abandoned when the originally coal-fired boiler plant was changed over to gas fuel. The entire condenser water-cooling equipment was built inside the old vaults. Before this idea was conceived by the designer, the owners were faced with the necessity of installing a cooling tower on the roof of the 9-story building, with its necessarily large water pipes, greater water-pumping head, etc. A cooling tower on the roof would have also required strengthening of the building structure, a very expensive step.

This novel idea saved the owners almost $10,000; power is saved daily because of the lower cost of pumping water. Additional power is saved on the refrigeration compressors because of more efficient water cooling; tests have shown that the "home-made," 2-stage cooling tower is cooling condenser water more efficiently than the average forced-draft tower.

Another feature of the air-conditioning system is use of the same finned coils for cooling in summer and heating in winter. This is accomplished by insertion in the chilled-water circuit of a shell-and-tube heater fed by steam from the engine exhausts. Thus a forced hot-water heating system results.

Low Operating Cost

The primary consideration of the designers of this project was lowest possible operating cost. On their department-store air-conditioning work, Sears Roebuck & Company have established operating costs substantially below those on the average department-store job. On this Dallas project, one year of operation of the air-conditioning plant shows that operating cost is less than that of any of the other Sears stores—all other conditions being equal, such as occupancy, weather, geographical location, etc. This is due mainly to the following points, according to Mr. Harbula:

1. Selection of ammonia as the refrigerant, which still has the lowest operating cost per ton of refrigeration, also the lowest cost per pound of refrigerant and the lowest loss of refrigerant per operating hour. The first cost of an ammonia refrigerating plant is also less than with any other refrigerant.

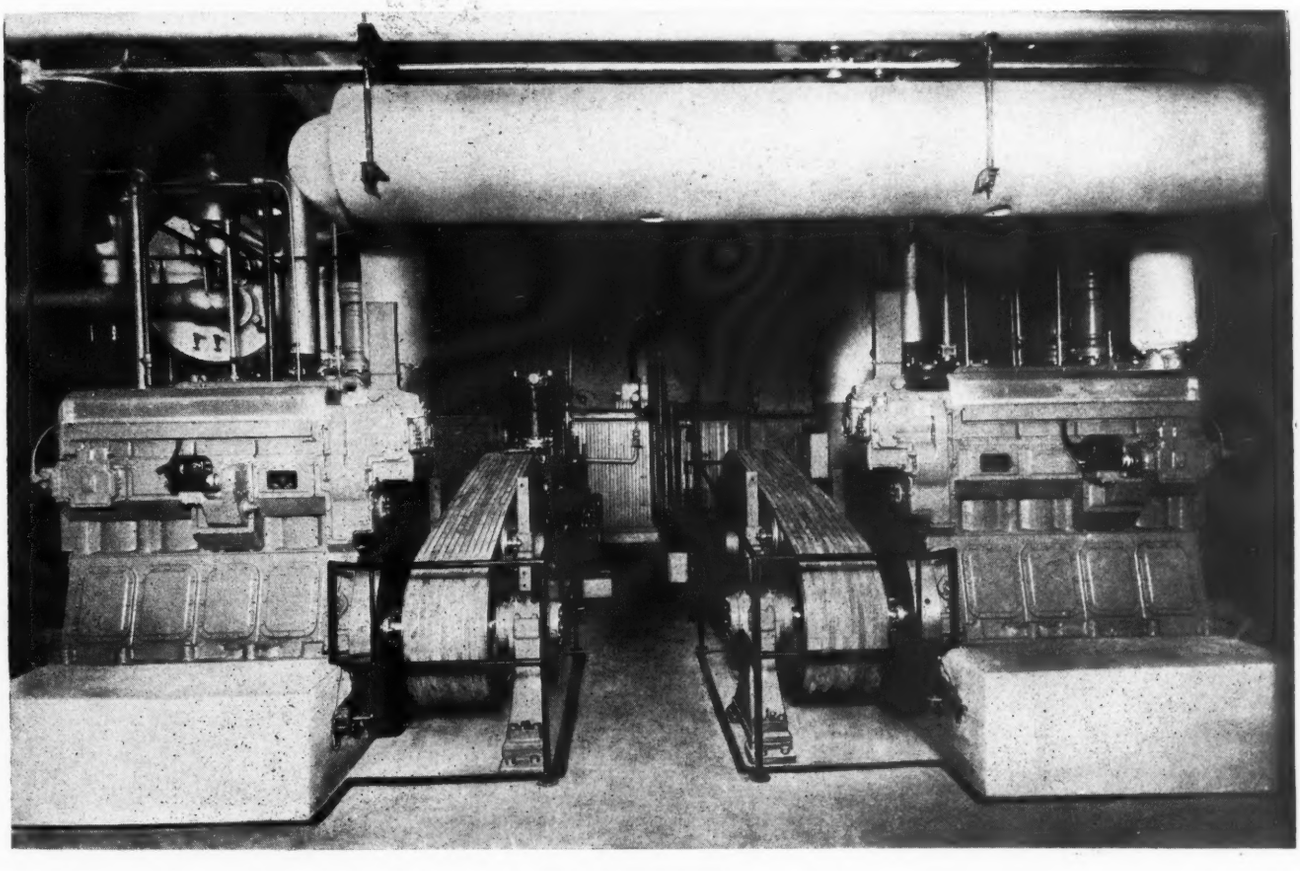
2. Selection of gas engines for driving the refrigerating machines; since the new 600-hp, 400-kw, gas-engine-driven generating plant is in operation in summer when exhaust steam for heating is not required, simultaneous operation of the gas engines for refrigeration and for producing power brings the cost of gas into the lowest possible rate bracket of the local gas company.

3. The "home-made" 2-stage condenser-water cooler brings condenser-water temperature closer to the prevailing wet-bulb temperature than is possible with a forced-draft cooling tower using equivalent power for moving air and circulating water; this results in lower head pressures on the ammonia compressors, lower brake horsepower per ton and resultant lower gas consumption on engines.

4. Location of the condenser-water cooler in the basement instead of on the building roof; this results in lower operating head on pumps due to lessened friction in much shorter pipe lines, resulting finally in lower cost for cooling the condenser-water cooler.

5. Selection of finned coils for cooling and dehumidifying air instead of the old, orthodox air washer, rapidly

Fig. 2—A closeup of the compressor drives. Note heavy exhaust-line insulation



becoming obsolete in the air-conditioning industry.

A major portion of the power during the summer is furnished by a 16x20-in., 600-hp, 277-rpm, Cooper Bessemer gas engine. The engine is readily convertible to diesel operation by changing the fuel system, etc., and is direct-connected to a Westinghouse 400-kw, dc 230-volt generator (See Fig. 3).

Lubricating Oil

Lubricating oil is handled by an Andale lubricating-oil cooler and filter in conjunction with a Schutte & Koerting lubricating-oil pumping unit. The exhaust outlet is through suitable exhaust piping and a Maxim silencer, exhaust piping being completely insulated against heat radiation in the engine room. There is a Brown pyrometer on the exhaust system. A large Vortex drum-type air filter and intake silencer is employed in the air intake, also equipped with suitable apparatus to prevent backfire in the air-intake pipe.

Engine speed is controlled by a Woodward isochronous governor. Close speed regulation is maintained at all loads. A separate cooling system for exhaust valves is provided by an Allis-Chalmers motor and centrifugal pump. The engine's cooling water is circulated by a motor-driven centrifugal pump with a city-water-pressure connection to be cut in for emergency purposes, in case of pump and motor failure. Cooling water is circulated through the engines and pumped to a natural-draft cooling tower. Suitable water control and alarms are used in conjunction with the entire cooling system.

As shown in the photographs, exhaust headers from the engines are heavily insulated to prevent heat radiation. Gas and water piping is identified by color and convenient arrangement overhead, with bends and turns avoided.

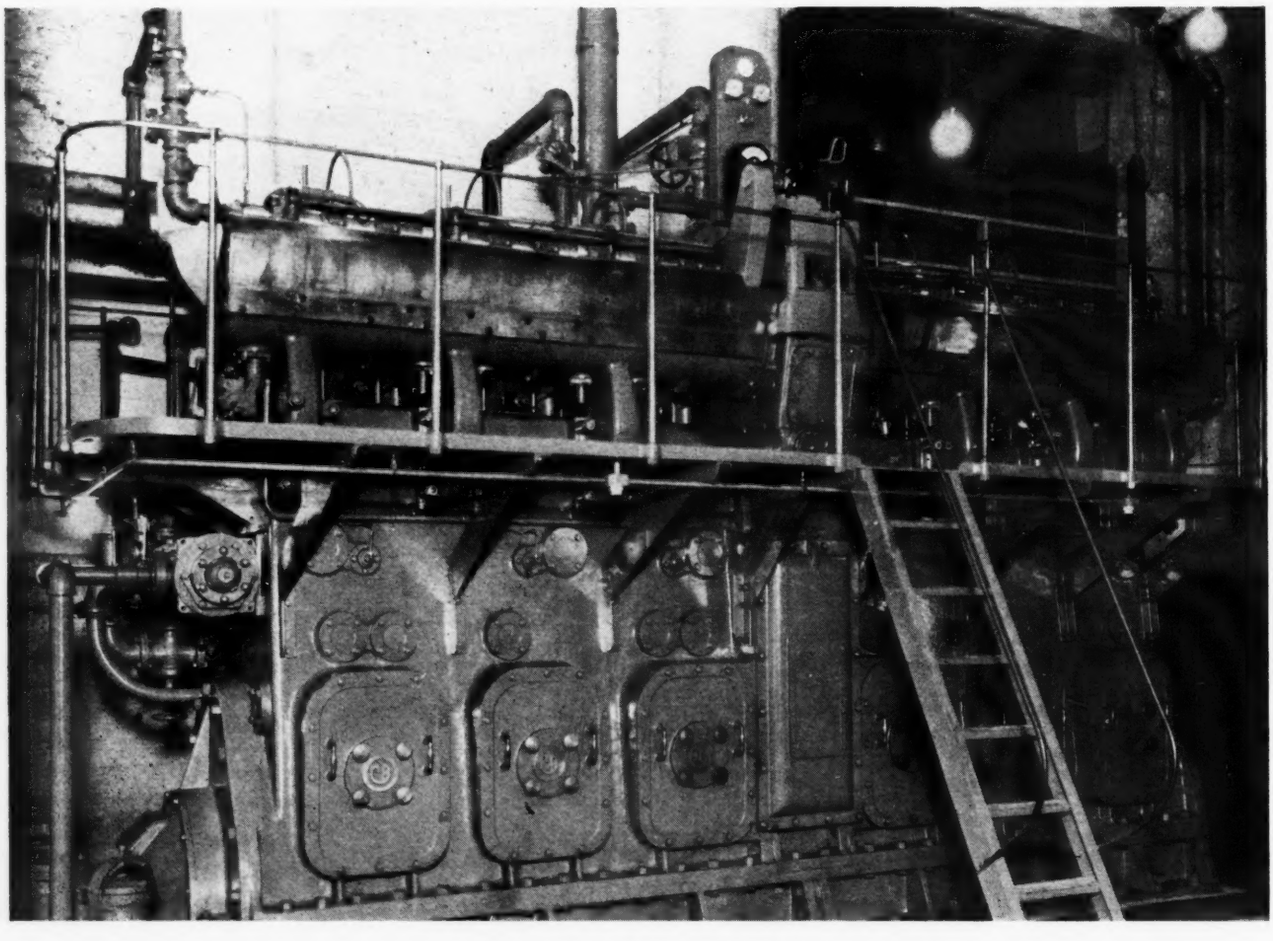
Engine Room

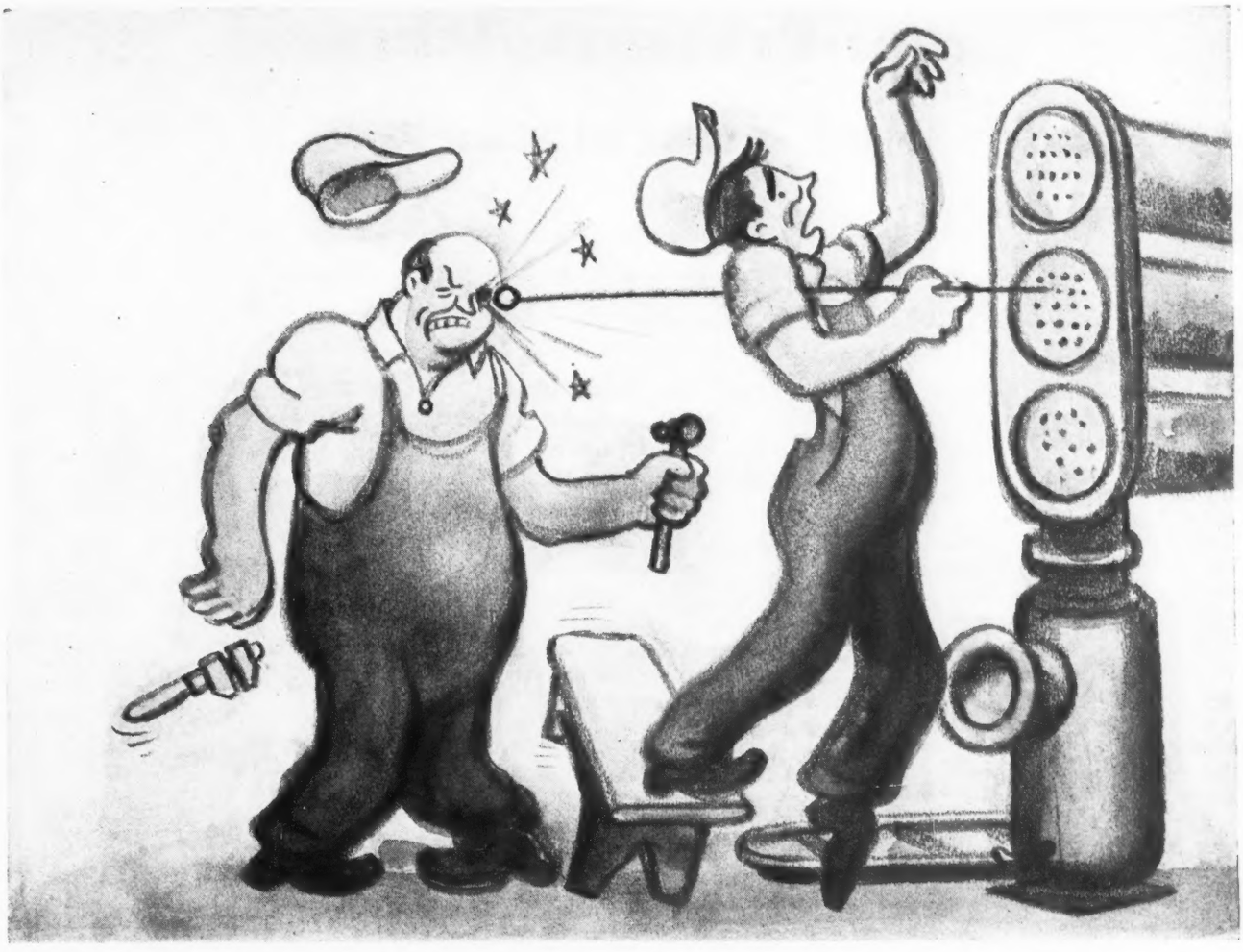
Foundations for all engines and compressors are isolated from the building foundation and floors by Mundet cork. There is not the slightest vibration to be observed or felt on the engine-room floor, and operation of the power plant cannot be detected in any other part of the building. Large exhaust fans ventilate the engine room. The entire refrigeration equipment is in the engine room adjacent to the engines and compressors. Water leaving the cooler of the refrigerating plant is pumped to the fan room, where the air is pulled through fin-type coils and blown through the air ducts for distribution to the various floors. Water is returned to the shell-and-tube type cooler for recirculation. A great deal of excellent engineering and design has gone into the development of air-conditioning systems for the various plants which Sears, Roebuck & Company now have in operation or under construction.

The system of air conditioning as well as the new gas-engine-driven power plant were designed and built under the direction of M. G. Harbula & Associates, consulting engineers of Wheaton, Ill., and constructed under the direction of Chapin Roberts, of the Construction Department, Sears Roebuck & Co, Chicago, and T. A. Hargrave, chief engineer of the Dallas plant.

The Dallas plant of this company has operated its own power plant since this plant has been in existence. Exhaust steam from the power units furnishes heating during the winter. There are two main steam engines, a 300-hp and a 450-hp Corliss engines, one of which operates during the summer to supply part of the load in conjunction with the 600-hp Cooper Bessemer engine.

Fig. 3—The 600-hp gas-engine-generator set supplies summer power





The Job of Accident Prevention

By S. H. Coleman

ACCIDENT PREVENTION is a major responsibility of the power engineer. No matter how well designed a plant is or how efficiently it is operated, failure of its supervisor and personnel to think and act safely at all times promotes injuries.

How and why do these accidents occur? Here is a list taken from the experience record of a large industrial organization, presented with the thought that by giving it publicity, similar occurrences in other power plants may be avoided.

1. Explosion in the ash hopper of a dry-bottom pulverized-fuel fired furnace.

An operator was seriously burned and a near-disastrous explosion occurred when an ash-pit door was opened too quickly. Because of very light load on the boiler, material resting against the door contained a large quantity of unburned carbon. This dust, agitated by the current of air rushing upward into the furnace, ignited and caused a bad flare-back.

2. Valve wheel on overhead valve insecurely fastened to the stem.

A fatality occurred when a chain-operated valve wheel came loose from its stem and fell, striking the operator on the head.

3. Floor grating removed and opening not roped off.

A maintenance gang left the opening unprotected and an operator unaware of the condition fell through, fracturing his hip.

4. Protruding stem of rising stem gate valve unprotected.

An operator suffered bad lacerations from violent contact with a stem projecting into a passageway.

5. Failure to wear goggles.

A maintenance man, chipping stoker grates, got a piece of material in his eye. The subsequent infection very nearly caused loss of sight.

6. Using a bench for a ladder.

An operator suffered a bad back injury when attempting to reach a valve while standing on a bench instead of the step ladder provided for the purpose. The bench tipped and the operator fell, striking his back.

7. Incompletely drained equipment when removing an evaporator from service for repair.

A mechanic loosening a flange on the bottom of the shell received severe scalds when the joint broke, suddenly allowing hot water to fall on his legs.

8. Coal sliding in unloading a car.

A laborer endeavoring to bar down a sticking mass of coal was seriously injured when it came loose.

9. Open heater overflows into pipe trench.

Two mechanics working in a floor trench were burned when overpressure blew the overflow-loop seal. All other possible chances of steam entering the trench had been safeguarded with locks and danger tags.

10. Running in an emergency.

An operator, running in performance of his duties, slipped, and in reaching out to catch himself, caught his well-worn monel (valve seat) ring on a sharp corner. All the flesh was stripped from one finger.

Vapor-Pressure-Actuated Dial Thermometers

Details of construction and operation of vapor-pressure-actuated thermometers and how to apply them to get accurate results. In September Power similar information was given on mercury-actuated types

By E. H. Hammond

Chief Engineer,
American S. & B. Instrument Div.,
Manning, Maxwell & Moore, Inc

VAPOR-PRESSURE dial thermometers stand second in the family of pressure-operated indicating thermometers, being out-ranked only by the mercury-filled type. They may range in quality from custom-built industrial types—characterized by excellent design, workmanship, and accuracy—to cheaper production thermometers built to perform a definite function, such as indicating water temperature in automobiles. In general, these cheaper types are limited in performance, accuracy being required at but one point of their range. Quality custom-built thermometers, however, must be extremely accurate at every point. They are standard throughout industry, and meet a real need for an accurate, remote-reading, and relatively inexpensive temperature indicator.

Pressure, Temperature Relation

They derive their name from being actuated by vapor pressure of a volatile liquid contained in the thermometer system. They operate in accordance with the physical law that, if a pressure-tight system is evacuated and then partially filled with a volatile liquid, Fig. 1, a definite relation exists between the liquid temperature and the pure vapor pressure above the liquid. In order that true vapor pressure be indicated at all times, the system is filled so that the bulb always contains a free liquid surface and a vapor space for all conditions of service. Vapor pressure inside the bulb is determined by temperature of the free liquid surface in the bulb, and the thermometer is calibrated to read temperature corresponding to vapor pressure.

Line lengths may be up to 200 ft. and no particular limitations apply to the capillary bore, except that it should not be too small or there will be some lag due to fluid friction. The usual bore ranges from 0.020 to 0.035 in. in diameter. Generally, bore and line length are not serious factors with vapor-pressure instruments.

A cheap form of vapor-pressure dial thermometer actuated by water vapor could be made from a standard pressure gage, a section of tubing, and a short piece of pipe to serve as a bulb. The system would have to be pressure tight, and free of air or gas. Using steam tables, the dial could be marked off in temperatures corresponding to pressure markings already on the gage dial. If this were done, it would be noted that the temperature readings do not increase at the same uniform rate as the pressure readings. Instead they become more widely spaced and easier to read near the upper end of the scale. This is explained by the fact that the vapor-pressure curve of water is not a straight line, but changes according to curve *A*, Fig. 2.

Vapor-Pressure Curve

Water seldom is used as a filling for dial thermometers, but whatever liquid is used, its vapor-pressure curve will have the same general characteristics as water. Vapor-pressure curves of the liquids used for fillings are similar in shape, but will not be parallel. The vapor pressure at a given temperature will be different for each liquid, as in Fig. 2, which shows the vapor-pressure curves for ethyl ether and ethyl alcohol. Other liquids used for various temperature ranges are propane, ethyl chloride and butane.

Power available for operating a vapor-pressure dial thermometer depends on the pressure increase in the system for a given increase of bulb temperature. All vapor-pressure thermometers are more powerful and accurate in the upper portion of their range than in the lower. Because of this characteristic, unit graduations become progressively wider from the bottom to the top of the scale, Fig. 3.

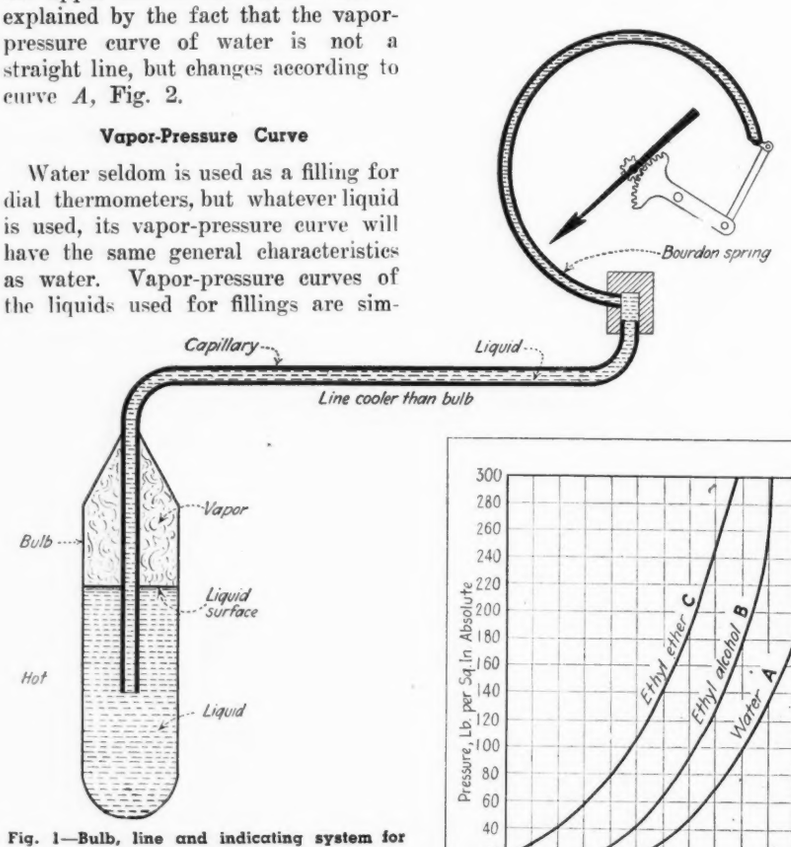


Fig. 1—Bulb, line and indicating system for a vapor-pressure-actuated thermometer (relative size of bulb exaggerated)

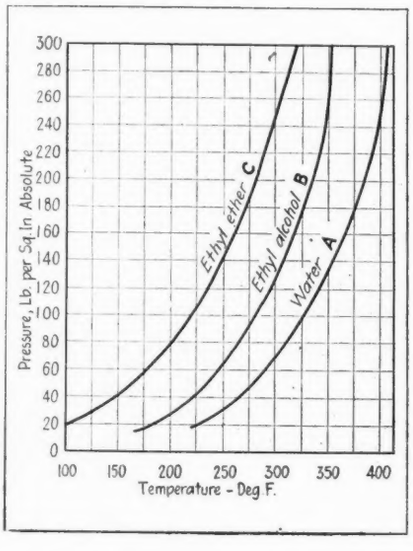


Fig. 2—Vapor-pressure curves for water, ethyl-alcohol and ethyl-ether, none of which are straight lines

Fig. 3—Dial graduations of a vapor-pressure thermometer increase toward the upper end of the scale

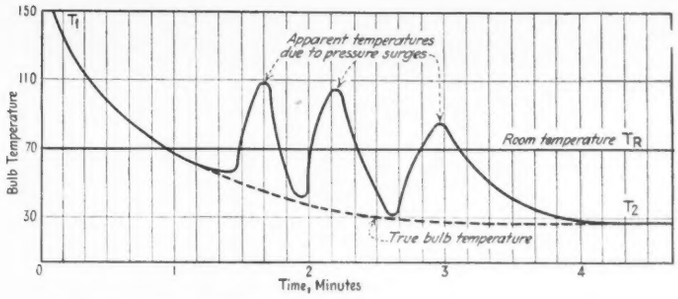


Fig. 6—Reversal phenomenon when vapor-pressure thermometer bulb is quickly cooled from above to below room temperature

Fig. 4—When the bulb is the hottest part of the system, the line and spring will be filled with liquid

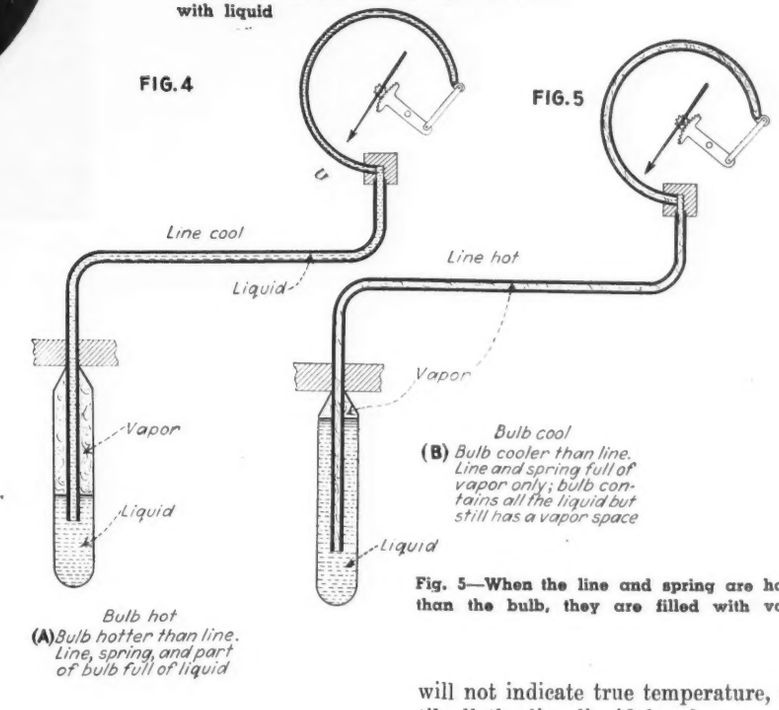


FIG. 4
FIG. 5
Line cool
Liquid
Line hot
Vapor
Vapor
Liquid
Liquid
Bulb cool
(B) Bulb cooler than line. Line and spring full of vapor only; bulb contains all the liquid but still has a vapor space
Bulb hot
(A) Bulb hotter than line. Line, spring, and part of bulb full of liquid

Fig. 5—When the line and spring are hotter than the bulb, they are filled with vapor

It is highly important, therefore, that a vapor-pressure dial-thermometer range be selected for actual service conditions. If possible, the working point should fall in the upper half of the scale, and the range should be as short as possible.

Operating Conditions

Satisfactory operation may depend largely on service-temperature conditions, and these should be specified when ordering. The three general classifications of operating conditions are:

1. Bulb always hotter than the line and spring.
2. Bulb always colder than the line and spring.
3. Bulb sometimes hotter, sometimes colder, than the line and spring.

It is a positive operating requirement that the bulb of a vapor-pressure thermometer always contain a free liquid surface for any temperature in the range.

As long as the bulb is the hottest part of the system, the line and spring will be filled with liquid, Fig. 4. If the line and spring become hotter than the bulb, they will be filled with vapor only, and all the liquid will be in the bulb, Fig. 5. In either case, the free liquid surface will be in the bulb, and correct bulb temperature will be indicated as soon as the line fluid reaches equilibrium.

During the interval in which the fluid in the line and spring is changing to either vapor or liquid, a phenomenon takes place which occurs only in vapor-pressure thermometers. When the line first becomes hotter than the bulb, the liquid in the line will be momentarily superheated and unstable, that is, it will be hotter than the liquid in the bulb, but will be under the same pressure. Under these conditions, vapor bubbles form to break the liquid thread in the line, and there will follow a sudden and progressive flashing of the liquid—exactly as would occur in a steam boiler if pressure were suddenly released. If there is no bulb elevation, the pointer will show the true temperature until boiling in the line first starts.

The first vapor flashed will be trapped by liquid still in the line, and will suddenly build up a pressure higher than that in the bulb, with an effect somewhat like a pressure surge, or series of surges, similar to that indicated in Fig. 6. The pointer will be quite erratic in action, and will indicate higher than true bulb temperature. The system will not reach equilibrium, and the pointer will not indicate true temperature, until all the line liquid has been vaporized or forced into the bulb, and until all liquid in the bulb cools to the temperature of the medium in which it is immersed.

If the vapor-filled line and spring become colder than the bulb, the vapor will be at a temperature lower than that corresponding to its actual pressure. Condensation must start immediately, and continue until sufficient liquid flows from the bulb to completely fill the line and spring. During this period the action of the pointer will be erratic and jerky, and indicated temperature will be lower than the true bulb temperature until line and spring are full of liquid, and equilibrium re-established. The time required to re-establish equilibrium will vary with the rate and extent of the temperature reversal, and with installation details.

This erratic pointer action and errors in temperature readings, occuring normally during reversals of bulb and line temperatures, can be compensated for by balancing the vapor-pressure system. If the tem-

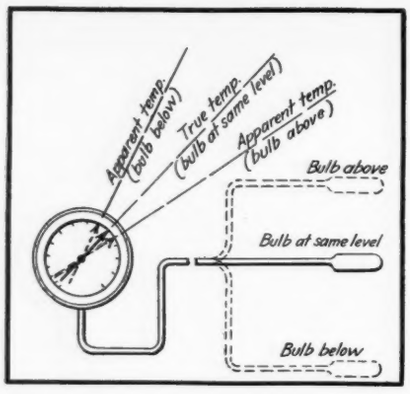


Fig. 7—How a change in thermometer-bulb elevation effects temperature indication unless pointer correction is made

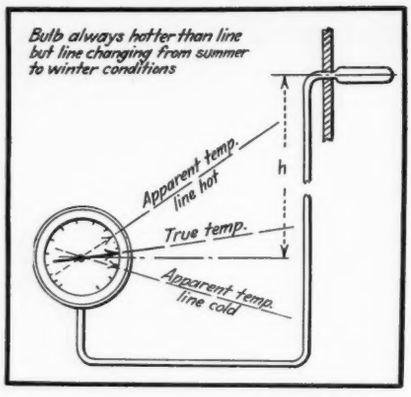

Bulb always hotter than line but line changing from summer to winter conditions
Apparent temp. line hot
h
True temp.
Apparent temp. line cold

Fig. 8—Changes in line temperature can cause errors in vapor-pressure thermometer readings if the bulb is elevated

perature range is such that reversals might take place in service, the thermometer specifications should state clearly that readings are not to be affected by such reversals.

Bulb Elevation

Vapor-pressure thermometers must be corrected for either positive or negative bulb elevations, unless line and spring are always full of vapor. When the manufacturer knows the bulb elevation, necessary corrections will be made at the factory, otherwise, the pointer will have to be reset after installation. Total pressure in the instrument spring will be vapor pressure in the bulb, plus or minus the hydrostatic head of liquid in the line. When the bulb is above the spring, the pointer must be set back so that it will not indicate the positive hydrostatic head; likewise, with the bulb below the spring, the pointer must be set ahead so that it will not indicate the negative hydrostatic head, Fig. 7.

A vapor-pressure thermometer which will be subjected to reversals of line and bulb temperatures should never be installed with either positive or negative bulb elevation unless the instrument is compensated for reversals, otherwise, it will be subject to an error, equal to the hydrostatic head, caused by the vaporization or condensation of the liquid in the line.

All distant-reading vapor-pressure thermometers installed with a bulb elevation are subject to at least a slight error resulting from changes in temperature along the line. The magnitude of the error for a given change in line temperature depends in part on thermometer range, bulb temperature, characteristics of the bourdon spring, but mainly on the bulb elevation. Hydrostatic head for a given bulb elevation depends on the density of the liquid, but line-liquid density changes with line temperature. Therefore, correction for hydrostatic head can be correct for but one line temperature, Fig. 8. Line error can be reduced to a negligible value by correcting for bulb elevation at mean line temperature, by selecting a filling with a low coefficient of expansion, by using as stiff a bourdon spring as possible, and by selecting a range to suit the working temperature.

In a few special applications, the accuracy of a vapor-pressure thermometer may be affected by changes in barometric pressure. Normally, this change is so small it cannot be detected on a commercial instrument. However, with airplane thermometers, the change in barometric pressure will be quite large, and must be compensated by properly selecting the filling and spring characteristics.

Advantages

A vapor-pressure system has this important advantage over other types: two or more pressure-responsive elements can be actuated from the same bulb without using special line compensation or bulb size. For example, a sensitive bourdon spring and a bellows can be made up as part of the same system, Fig. 9, and operated from the same bulb. The bourdon spring will indicate the temperature accurately, and the large area of the bellows will insure ample power for operating auxiliary devices, such as mercury switches, self-actuated and pneumatic servo-motors, and similar power units. Multiple systems must be so designed that they will not cause sudden or large displacement of liquid from bellows, due to external loads.

A vapor-pressure thermometer will not necessarily indicate the hottest temperature to which the bulb is exposed. That is, the bulb does not have the hot-spot characteristics sometimes attributed to it. Neither is it of the true averaging type, as are mercury-, gas-, or liquid-filled thermometers. If for example, only part of the bulb is immersed in a hot liquid, the rest being in a cool liquid, true temperature of the hot liquid will not be indicated. This is because heat is flowing from the bulb to the colder liquid, and the temperature as indicated will be that at which heat flow into the bulb just equals the flow from it.

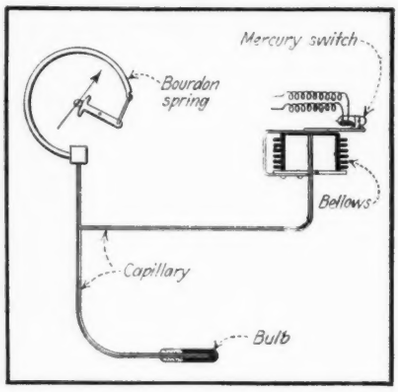
A long bulb will not necessarily give the mean temperature along its length. Temperature at the free liquid surface in the bulb will determine the vapor pressure, and thus the temperature which will be read on the dial, which will be somewhere between the temperature of the hottest and coldest parts of the bulb. Because it is non-averaging, a vapor-pressure bulb should be kept as short as possible, and great care taken to insure that it is installed at a point which will give a representative and true temperature.

Small Thermometric Lag

Properly designed vapor-pressure thermometers have very small inherent thermometric lag. For this reason they are well adapted for services where the response must be quick, as for example, when used to indicate rapidly fluctuating temperatures.

There are a large number of vapor-pressure ranges from which to choose, and a desirable standard range can be selected for almost any working temperature between minus 40 and plus 650 F. Low-temperature ranges are limited by lack of available filling liquids with sufficiently low boiling points and proper vapor-pressure characteristics. Higher-temperature ranges are limited partly by lack of suitable high-boiling-point liquids, and partly by pressure limitations of thermometer springs, and by requirements as to width of range. Thermometers for low-temperature ranges must have a relatively short temperature scale to provide accuracy at the lower points. This makes it necessary to protect the instrument against over-ranging when the bulb is subjected to higher temperatures during shipment and installation.

Fig. 9—A sensitive bourdon-spring instrument and a bellows can be operated from the same bulb



Static Electricity in Industry

In many industrial processes, static electricity is a possible menace. This article shows how it can be eliminated

STATIC ELECTRICITY is generated in many industrial processes and operations—in the manufacture of textiles and paper, the mixing of pigments, ginning of cotton, by gasoline in motion, in paper as it passes through printing presses, in belt elevators handling grain and other materials, and, most familiar of all, in power belts. Under some conditions these charges interfere with manufacturing processes, in others they create a serious fire and explosion hazard.

What Causes Static

Originally believed to be produced always by friction, static electricity became known as "frictional electricity. Even today it is generally believed that static in belts is produced by friction of air on the belt, friction of the belt fibers on each other as they bend around the pulley, friction caused by stretch and contraction of the belt as it runs from tight to slack side, and friction caused by creep or slip on the pulley.

The late Dr. Elihu Thomson, however, has shown that static electricity in a belt is generated by contact and separation of the belt and pulley. A difference of potential exists between two unlike materials; the belt surface as it leaves the pulley acts as a condenser. As the distance between a given spot on the belt and the pulley increases, the potential is built up until a charge is dissipated from the belt edges.

When belts operate at high speeds in dry atmosphere, they frequently become heavily charged with static electricity. Low temperatures appear to be more favorable than high temperatures for accumulation of these charges, although they may become serious in any dry atmosphere. In one case a potential of 75,000 volts was measured on a 22-in. leather belt connecting a high-speed motor and a flour mill.

A wooden pulley on the driven machine and a metal pulley on the motor may cause high static potentials from the belt to be built up in the motor frame, if it is insulated from ground. Cases are on record where motor insulation has been damaged from this cause. When the motor has ball bearings, it generally can be protected against these potentials by grounding the frame. The oil film in sleeve bearings may be sufficient to insulate a rotor shaft from the motor frame. In such cases, ground the rotor shaft if belt static is serious and cannot be removed effectively.

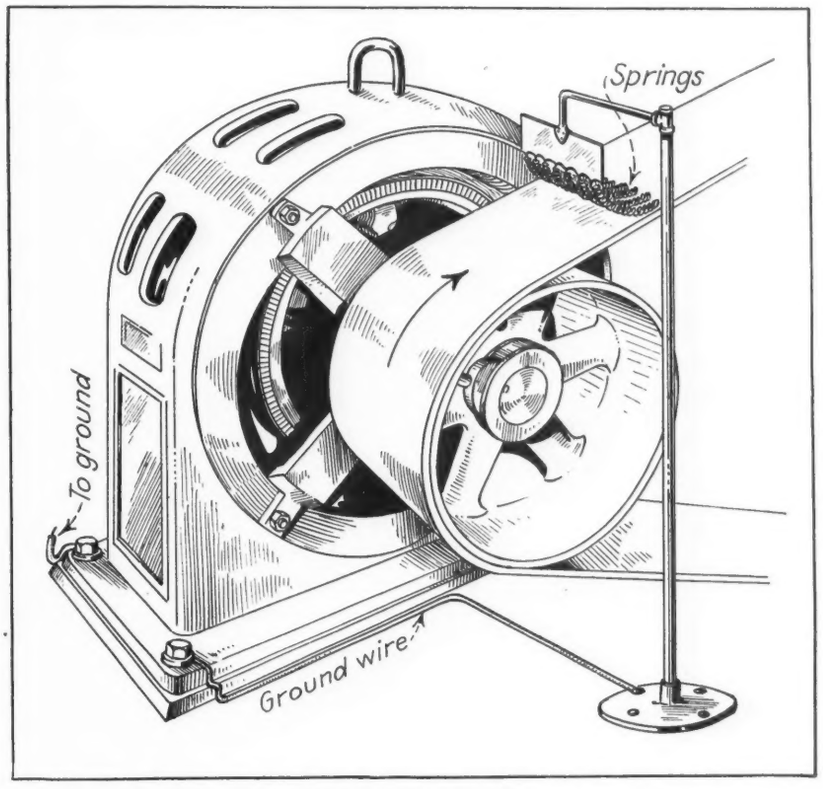


Fig. 1—Grounded metal springs ride on top of belt to remove static charges

Belt conveyors frequently become highly charged with static electricity from the causes already cited and in addition, friction of material on the belt. On one such rubber belt operating at 750 fpm, potentials up to 45,000 volts were measured. Investigations made by the Bureau of Chemistry, U. S. Department of Agriculture, showed that higher potentials exist in elevator equipment handling smutty grain; clean grain is not as troublesome. Explosions have been caused in grain elevators, attrition mills, threshing machines and other equipment by static electricity discharging to ground from various parts of the equipment or between these parts.

Where inflammable gas and dust are present, there is always danger of fire or explosion, started by a spark from a belt, and most fires and explosions caused by static electricity occur in winter when indoor humidity is low and buildings are heated.

Surface conductivity of materials becomes greater as relative humidity of the surrounding air increases. Consequently, where possible, maintaining a fairly high relative humidity prevents accumulation of dangerous electrical charges. High-speed printing presses are an exception, however, as it has been found that increase in relative humidity is not completely effective. Ionizing the air that surrounds belts and other surfaces by high-voltage ac or by a gas flame will also remove the static charges.

Dressing the Belt

A third method is dressing the belt surface with a compound which makes the belt sufficiently conductive to neutralize the charges as they accumulate. "Belt Dressings for Eliminating Static," by P. W. Edward and J. O. Reed, Bureau of Chemistry & Soils, U. S. Dept. of Agriculture, suggests a rubber-belt dressing of 18 parts

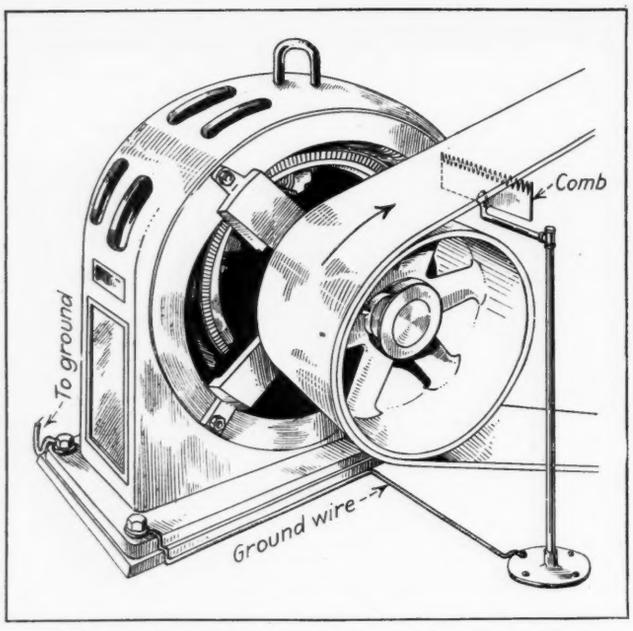


Fig. 2—Most static is generated on a belt's inner surface and can be removed by a metal comb

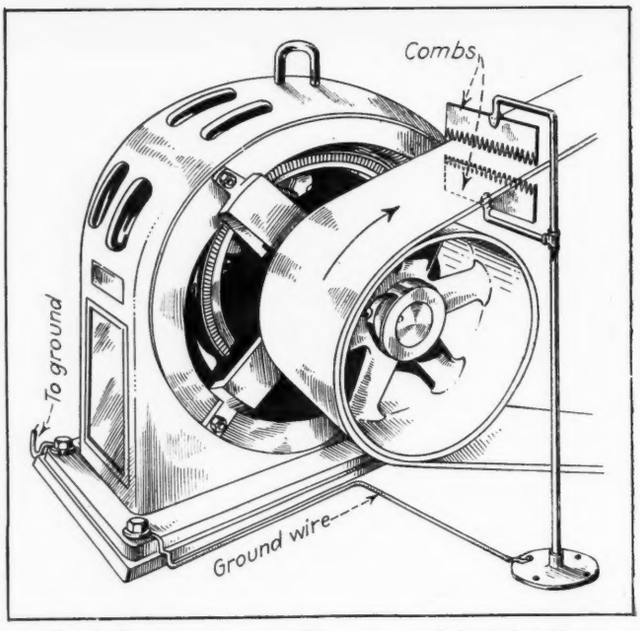


Fig. 3—For severe static conditions, a grounded metal comb may be required near both surfaces of the belt

of lampblack to 82 parts of good spar varnish. The dressing must dry on the belt before using. A non-inflammable thinner for the varnish may be made by mixing equal volumes of carbon-tetrachloride and painters naphtha.

Non-Static Dressing

A non-static leather-belt dressing of merit is a mixture of 100 cc liquid fish glue, 80 cc glycerine, 100 cc sulphonated castor oil, 170 cc water, 82 grams lampblack and 20cc 2% ammonium hydroxide. These proportions may not be best for all conditions, and in some cases, better results may be obtained by increasing the quantities of fish glue and glycerine. The mixture is easily applied with a brush while the belt is in motion, and it is not necessary for the dressing to dry before running. A leather-belt dressing to prevent static has also been made of a simple water and glycerine mixture.

Suspending an effectively grounded metal comb near the belt surface is a common method of removing static. In some cases, fine wire springs are soldered to the comb and allowed to touch the belt, Fig. 1, which has the advantage of directly grounding the belt surface. Most schemes for grounding belt surfaces have been applied to the outside of the belt. However, according to theory, the major portion of the charge is on the inner surface of belts, which, in some cases, undoubtedly accounts for ineffective removal of static by combs applied to outside surfaces of belts.

Placing the comb close to the point where the belt comes off the pulley, Fig. 2, will remove a major portion of the charge as it is produced. The grounding device should also be applied to the belt strand leaving the pulley, as in the figures, because it is in this strand that most of the charge is generated. Necessity for properly grounding the comb cannot be too strongly emphasized, since the protection, to be effective, must have an easy path to ground. Whenever possible, connect the ground wire to a water pipe with a substantial clamp in intimate metal-to-metal contact with the pipe. Take equal care in making the connection to the comb. For very severe conditions, it may be necessary to apply a comb to the inside and outside of the belt, Fig. 3.

Practically all industrial processes generate static electricity, but fortunately they are dissipated in many before they produce objectionable effects. Many serious fires and explosions occurred in cotton gins before the principal cause, static electricity, was found. These fires were particularly prevalent during the season when humidity was low and the cotton dry and dirty. These conditions, according to U. S. Bureau of Chemistry & Soils, are essential for high electrostatic charges in cotton gins.

These charges have been eliminated by wetting down the plant once or twice a day, by hanging up wet bagging, injecting a small amount of steam into the cotton as it enters the gin, and by grounding all metal parts of the gin. The latter method is recommended by the U. S. Dept. of Agriculture, using two metal rods at least $\frac{3}{8}$ in. in diameter or $\frac{3}{4}$-in. iron pipe driven at least 4 ft into the earth for the ground connections. Soil around these connections should be kept moist.

Considerable trouble with static electricity has been experienced in textile mills in carding and spinning. Cotton, wool, and other fibers readily contract a charge of static electricity, resulting in a tendency for them to separate by repulsion of like charges. These conditions are most severe in cold dry atmosphere and may interfere with production and reduce product quality. Humidifying the atmosphere by various means has been found effective to a degree, but the moisture tends to wet and rust equipment and causes objectionable working conditions.

AC Neutralizers

High-voltage ac neutralizers are used extensively on machinery in textile, paper, printing, rubber, artificial-leather, oil-cloth, sandpaper and other industries to remove static electric charges from products in process of manufacture. These neutralizers have a small transformer, designed for approximately 12,000 volts on its secondary side. One terminal of the transformer connects either directly or inductively to an insulated rod having a number of metal points which may or may not have a connection with each other. In any case, the ionizing points are placed 1 to 3 in. from the material being processed. The other secondary terminal of the transformer is grounded. The metal points create a static electrified field, which alternates in positive and negative polarity. When material that is

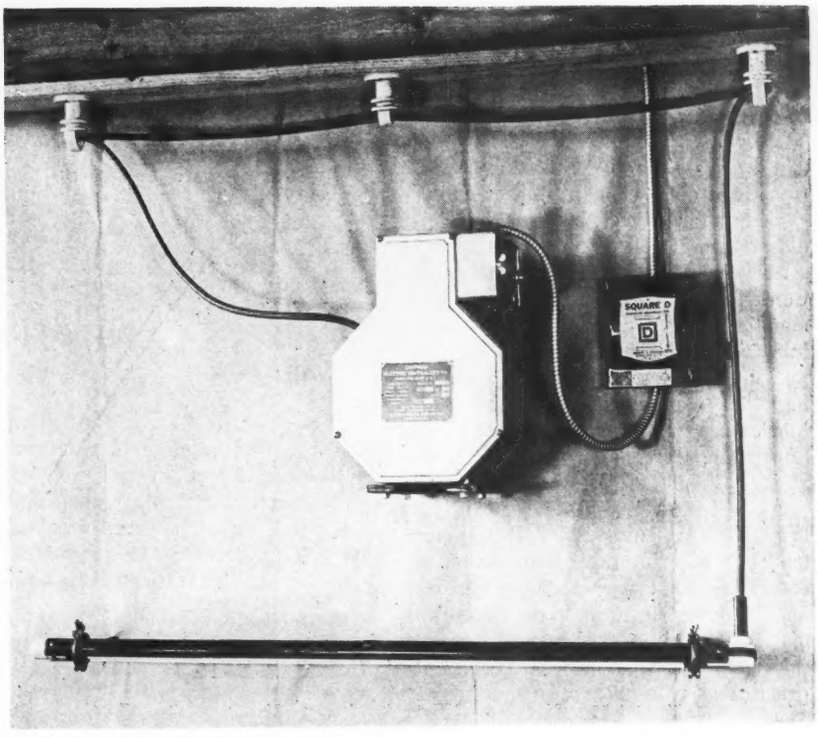


Fig. 4—High-voltage ac neutralizer used for removing static charges from materials in manufacturing processes

statically charged comes into the influence of this ionized field, it is neutralized.

Paper leaving printing presses is sometimes passed over gas flames to dissipate the static charges. The flames form a conducting path to ground for the static electricity on the sheets and help to dry the ink. This method is limited to those applications where non-inflammable inks are used, and is automatic in operation, using gas properly mixed with air to produce perfect combustion. An electro-magnetically controlled device automatically turns on the gas and ignites it when the press starts and turns it off when the press stops.

Static charges are produced in the materials used in manufacturing paints and pigments. If the solvents are inflammable, there is always danger of fire. Grounding of all metal parts of the processing equipment is not always a 100% preventative, therefore it is advisable to have a fire extinguisher near at hand for immediate use.

Pouring Static

When gasoline or other distillates are poured at high rate from a nozzle into a tank that is insulated from ground, a static charge is produced in the tank. If the nozzle happens to be brought near the tank a spark may occur between the two, which is likely to cause a fire. Grounding the tank and nozzle is not always effective as apparently static charges may form on the surface of the liquid in the tank, of sufficient potential to flash along the surface. The discharge is similar to sparks that may shoot across the surface of paper as it comes out of paper-mill calender rolls.

W. H. Chapman, general manager, Chapman Electric Neutralizer Co., has proposed a method of eliminating this hazard that consists of a flexible float of conducting material resting on the liquid surface and connected to the tank by light weight chain. The truck tank is connected by a wire to the grounded storage tank being filled. In this manner, static charges are carried away from the surface of the liquid before potential becomes dangerously high. Allowing the gasoline to flow through a fine wire-mesh strainer, attached to the tank, as it leaves the nozzle should effectively carry the static charges to ground through the tank, if the tank is properly grounded.

In industrial equipment, static electrical charges are produced under so many different conditions that it is impossible to suggest standard rules for eliminating them. Methods that have given complete satisfaction in one case have failed under similar conditions in other localities. One of two similar machines operating in the same room may be practically free of static electricity, or if static charges are produced in it they are easily eliminated, yet on another machine all means of removing the charges apparently fail. Frames of all equipment where static charges are present should be effectively and permanently grounded, however, whether it gives the necessary relief or not.

Sources of information consulted in writing this article include "Standard Handbook for Electrical Engineers," literature of the Chapman Electric Neutralizer Co., Portland, Me.; and Craig Sales Corp., New York, N. Y.; and the publications "Belt Dressing for Eliminating Static" by P. W. Edwards and J. O. Reed; and "Static Electricity as a Fire Cause," by E. E. Turkington, published by National Fire Protection Assn, Boston, Mass.

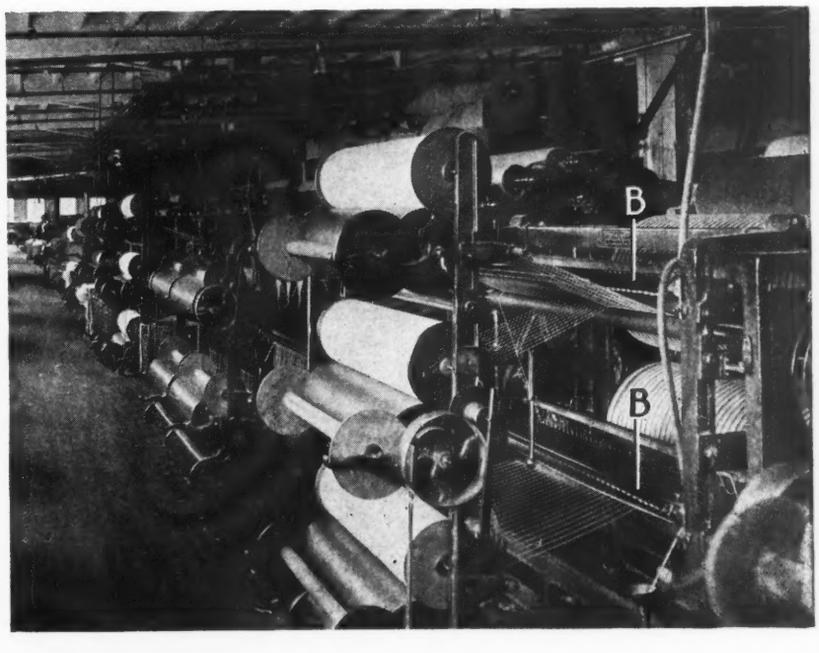


Fig. 5—A line of woolen cards, each equipped with two high-voltage ac neutralizer bars at *B* remove static charges generated in wool as it is being processed

Correct Lubrication Is Vital

Here are the features necessary in a lubrication system to obtain reliable, trouble-free and low-cost operation

By James I. Clower
Associate Prof. of Machine Design, Virginia Polytechnic Institute

LUBRICATION is the life blood of a machine. Builders realize that, regardless of how well it is designed and constructed, a machine cannot render efficient and satisfactory service unless it is correctly lubricated. Consequently they are constantly demanding more reliable and automatic lubricating appliances. Likewise, important machinery users are specifying that machines be as near self-lubricating as possible and that the lubricating system be as well developed as the productive elements.

As a result, manufacturers of lubricating appliances and systems have made greatly improved equipment in recent years. Many machines formerly hand lubricated now have full-automatic circulating systems or, where such a system is too expensive or impracticable, one of several designs of a centralized system.

Essentials

Some lubricating appliances and systems are simple, having only a few parts; others have a multiplicity of parts with automatic alarms which show a light or ring a bell should lubricant fail or bearing temperature become excessive. Regardless of design and purpose, the following essentials should be considered in selection:

Reliability. Should the lubricant supply stop, even momentarily, serious damage may result. Moreover, production will be reduced, the cost of which will generally far exceed the cost of repairing the machine. Bearing failure on a single machine will often disrupt production of an entire department and sometimes of the whole plant. Therefore reliability is a first consideration when selecting a lubricating system.

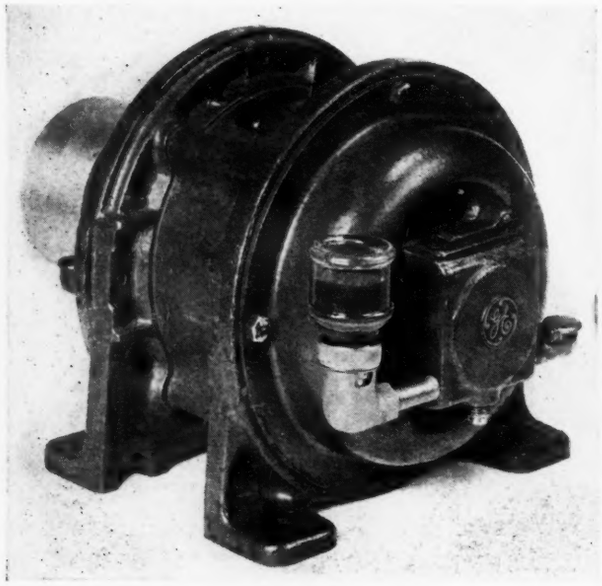
Automaticity. The appliance or system should start and stop supplying lubricant automatically when the machine is started and stopped. This feature is highly desirable and eliminates the uncertain human element. Neglecting to start feeding lubricant when the machine is started usually results in burned-out bearings, damaged gears, etc., entailing a shutdown, costly repairs and time out of service. Forgetting to stop the lubricant feed when a machine is stopped causes a waste of lubricant, creates an unsightly mess and fire hazard, and requires added labor cost for cleaning the machine and refilling the appliance.

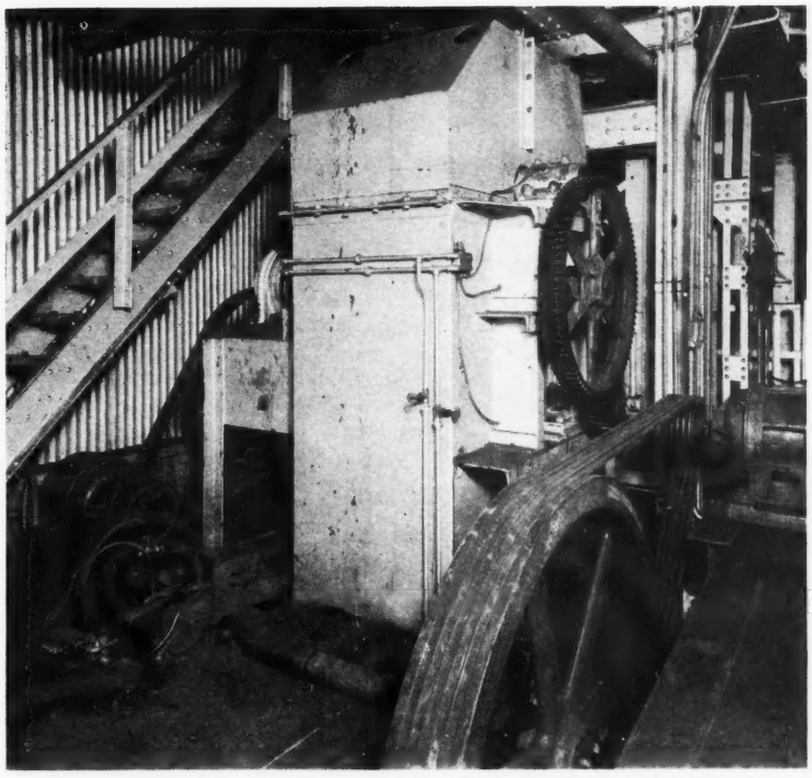
Accessibility. Regardless of precautions to prevent ingress of dust and dirt, all lubricating appliances and systems all require cleaning at times. Too frequently lubricating containers, such as drums, cans and tanks, are left open or partly uncovered, consequently dust, dirt, water, and other impurities get into the lubricant and lubricating system. Few if any lubricating systems are completely enclosed. Considerable quantity of atmospheric dust and dirt may get into them through vents, breather pipes, etc., especially if the machine is in dirty surroundings. All lubricants, regardless of initial purity, oxidize to some extent in service, causing a deposit, commonly called sludge. Sludge may have a liver-like appearance or it may be a dry-punk deposit. It may clog oil holes, passages, grooves, feed-control valves and other parts, and must be occasionally removed to avoid trouble. Accessibility for both cleaning and repairing is therefore highly desirable in any lubricating device.

Close Feed Regulation. This characteristic is desirable in order to obtain proper rate of feed. Over-lubrication may be as serious as under-lubrication. It has been stated that with anti-friction bearings, over-lubrication causes more failures than any other single item. Air compressors are likewise sensitive to over-lubrication. Too much oil in air-compressor cylinders produces so-called carbon deposits, which in turn cause leaky discharge valves, ineffective operation of piston rings, and excessive operating temperatures. Most air-compressor explosions and fires are traceable to over-lubrication. Over-lubrication also wastes lubricant, creates a mess and a fire hazard. In other instances, the excess lubricant is thrown onto belts and electrical equipment, thereby damaging them. In food-preparation establishments and textile mills, over-lubrication often causes damage to the product.

Feed Proportion to Demand. In general, if the speed of a machine increases, so should the rate of supplying lubricant. High speed produces an increase in the lubricating-film pressure, which increases end leakage. A change in the rate of feed is not only desirable from a lubrication standpoint, but the lubricant may act as a coolant and, in such cases, an increased feed is required for cooling purposes when speed increases. In many lubricating appliances, the rate of feed increases too rapidly with temperature, because of reduction in lubricant viscosity with temperature rise. In some designs, an attempt is made to compensate for temperature variations, but usually the rate of lubrication feed from such appliances depends on temperature fluc-

Constant-level lubricators automatically maintain oil level constant in ring-oiled bearings, motors, lineshafts and other equipment





Shaker screens and bucket coal elevator, grease lubricated from a central-pressure system

tuation and not on temperature head.

Many variable-speed machines drive their own lubricating appliance machine. When machine speed increases or decreases, the lubricator automatically supplies more or less lubricant.

Easily Refilled. In many lubricating devices, the filling hole is too small, causing oil to be spilled when the lubricator is being filled. Filling holes should be large and easily accessible.

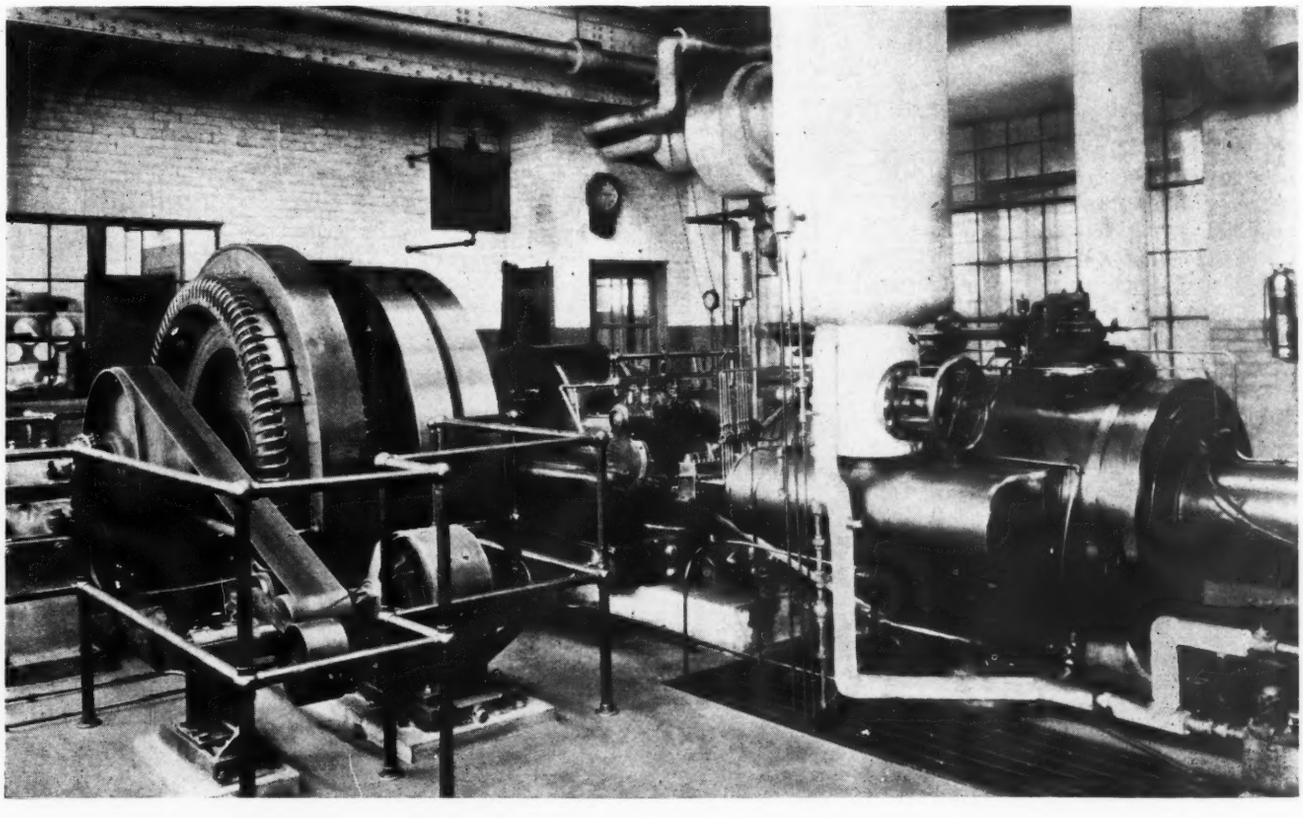
Reasonably Priced. It is seldom profitable to purchase lubricating appliances and systems solely on a first-cost basis. Maintenance costs of both the device, machine and the effect of a forced-shut-down should be given first consideration. If operation of a department depends on a particular machine, then a few dollars saved when buying a lubricating device may result in an expenditure far in excess of the original saving.

Probably not any one appliance or system possesses all of the seven features outlined. Obviously, some may be of little consequence for certain applications, while others are of prime importance. Make a careful analysis of the lubricating requirements of the machine, then select the system that fulfills the needs to the greatest degree.

Conditions Determine Method

In some cases it is necessary to install different systems on the same machine when operated under different condition. In many instances machines are not equipped with one system only, but with a combination. For example, internal parts of a machine may be provided with a splash, bath or circulating system, while external parts are lubricated with drop-feed or wick-feed oilers. Also, it is not unusual for certain parts of a machine to be lubricated with grease while at the same time other parts are oil lubricated.

Steam-engine-generators may require several types of lubrication, such as a central mechanically operated system, drop-feed cups, ring oiling, and splash oiling

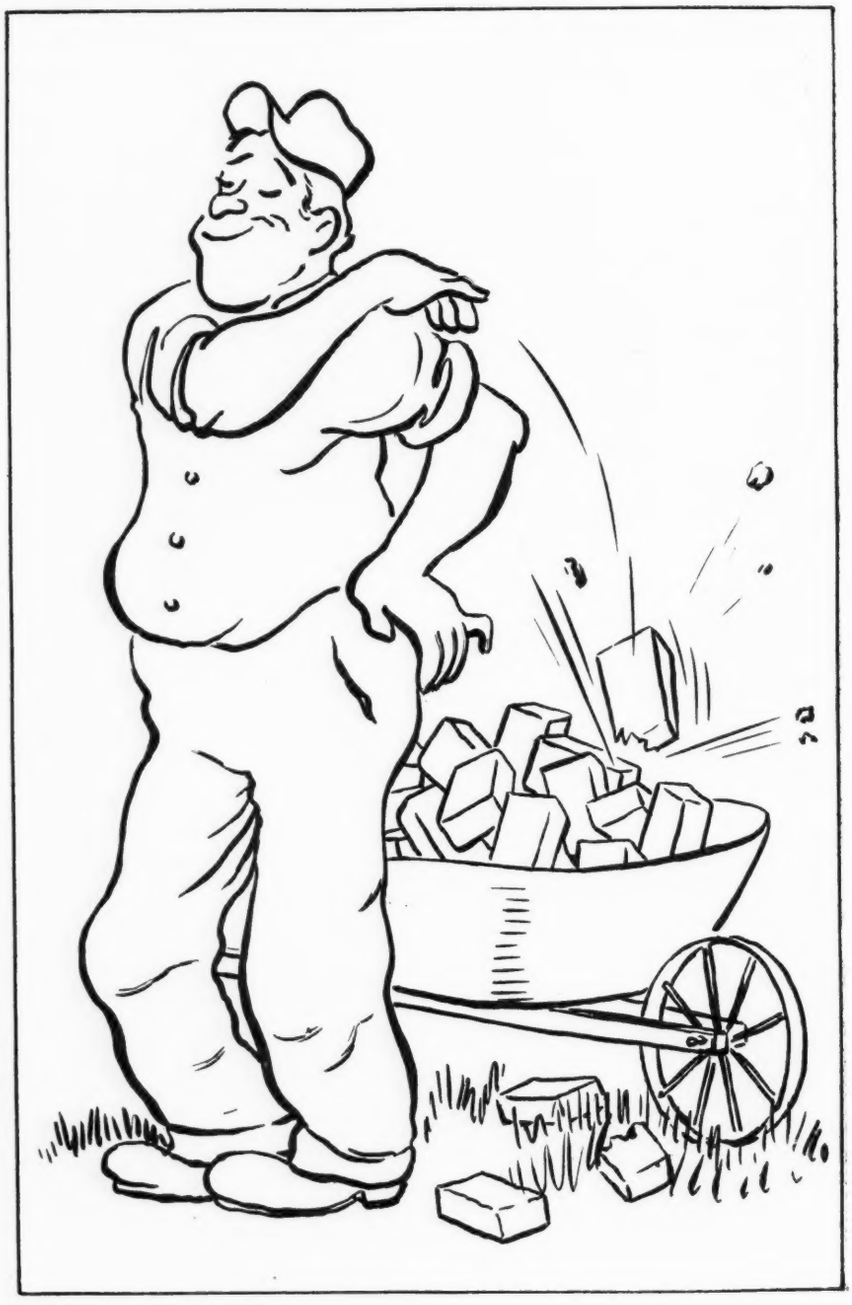


Longer Life for Furnace Walls

Careful operation is the surest way to keep down cost of furnace maintenance and to avoid troublesome shutdowns

CUTTING THE COST of furnace maintenance depends first on selection of the brick best suited to the conditions and second on the care with which the furnace walls are treated. Selecting brick from the many types available to meet the almost innumerable combinations of furnace conditions is a complicated process, but it doesn't usually worry the operating engineer; his job is to operate and maintain a given furnace and to do it as well and as cheaply as possible. Let's take a look at some of the things that bring furnace walls to an untimely end, and then let's see what can be done about them.

A good start can be made by seeing that firebrick, whether for new walls or repair, is handled carefully. Scuffing, cracking, and breaking of corners and edges doesn't harm common brick, but it is hard on brick that is going to have to support considerable load under high temperature. See that your expensive refractory brick doesn't get tossed into a wheelbarrow and isn't unceremoniously dumped into a corner. In any handling operation, the brick should be stacked, and it's better to stack on edge rather than flat. Store refractories in a dry, protected place, since moisture and frost may weaken their bond and shorten their life.



Starting a New Furnace

Breaking in a new furnace lining is as important as breaking in a new car. Taking it easy is recommended in both cases. Slow heating and plenty of circulating air is the recipe for drying out the moisture gradually. Rapid heating tends to form steam in the pores of the brick or in the mortar and may cause serious damage. Caution is just as important when starting up after repairs as when starting a new furnace.

Furnace temperature should not be raised above 400-575 F until all steaming from the drying brick and mortar has ceased. Look out for flames which lick against the brickwork during the heating-up period. Direct contact with the flame may cause rapid local expansion and spalling.

Complete combustion pays dividends in maintenance savings as well as in the more widely advertised fuel savings. Under certain conditions, carbon monoxide, sign of incomplete combustion, will attack furnace walls. What happens is this: Gas penetrates the heated, slightly porous brick and the carbon monoxide decomposes into carbon dioxide and carbon. When this occurs within the body of a brick, continued deposit of carbon weakens the bond and causes disintegration. Partially cracked natural gas may have an effect similar to carbon monoxide.

Furnace gas attacks walls in another way, perhaps a more common trouble in some types of furnaces. When high gas velocities exist, solid particles tend to erode the lining. Troubles of this kind are usually met at points where the gas passages are restricted or where a sudden change

in the direction of gas flow takes place. Uneven draft conditions, resulting, for example, from uneven tuyere settings, are another cause of local high velocities and erosion.

Another enemy of furnace linings is the slag which forms at high temperatures from the ash of most fuels. Some slags tend to flow over the furnace walls, leaving only a thin coating, if any. The extent to which the brick will suffer depends on the composition of the slag and of the brick. Usually the lining gradually becomes thinner as the brick material is dissolved by the slag and washed away, and as undissolved particles become loosened and are also washed away. Severe slagging of this type is usually first noticeable in the joints, as the ordinary fire-clay usually employed for bonding cuts out rapidly. Attack at this weak spot hastens the destruction of the remainder of the wall since furnace heat penetrates further into the brick making it react more readily with slag.

Under other operating conditions, slag may form a coating which increases in thickness. Removing such a slag coating is a recurring headache and usually leaves the walls in poor shape. A certain amount of chipping and cracking from the tools used is unavoidable, and portions of the brickwork are likely to be torn away with the slag.

Watch Operating Temperatures

To avoid slagging troubles, two temperatures have to be watched, the fusion temperature of the ash and the temperature at which the slag and firebrick will react. It's easier, of course, to avoid slag entirely by using a fuel with a high-fusion temperature and keeping the furnace temperature below this point. Unfortunately, this simple solution is frequently impossible, either because low-fusion fuels must be used for other reasons, or because furnace temperatures must be high. If slag formation can't be avoided, the next best thing is to keep down the damage. Slag does its worst when it reacts with the brick, eating it away rapidly. Careful observation of furnace operation may make it possible to keep the temperature below that at which the slag and brick can be seen to react. If you have no slagging troubles now, think twice before changing the type of fuel or method of operation.

Breaking and cracking of furnace walls results from several causes, but the greatest offender is abuse of the thermal properties of furnace brick. Firebrick, like most other materials, expands when heated but unlike most other materials, it is usually heated to high temperatures and subjected to substantial loads at the same time. Firebrick softens at temperatures well below those usually met in a furnace, which means that the fire side of the wall isn't able to help much in carrying load. It is all transferred to the small area at the cool side of the wall. The hotter the furnace, the further into the wall the softness extends, consequently the smaller the area of firm brick left to take the load. Operating under overload conditions with high furnace temperatures imposes a severe strain on walls. It is equally important to look out for localized heating or "hot spots," as considerable damage may result from overheating of even short duration.

In connection with furnace temperatures, it is well to remember that refractories begin to soften at a point considerably below the fusion temperature specified for them. This is due to the fact that fire clays are mixtures of several materials. Thus some parts of a brick may start to soften and melt several hundred degrees below the fusion temperature for the entire brick. Allowance for this must be made in determining the safe operating temperature for a furnace. It's best to operate some 500 F below the fusion temperature specified for the furnace brick.

Rapid changes in temperature are just as hard on furnace walls as sustained high temperatures. Temperature changes such as result from banking and firing-up cause rapid contraction and expansion of the brick, and some refractories just can't take it. The practice of quenching walls to remove slag produces a terrifically sudden contraction—that's why it removes the slag—but it can't fail to damage the lining. Related sources of trouble are the leaks which occasionally develop in water-cooled furnace parts, since they constitute quenching on a small scale.

Changing Furnace Design

If a furnace lining fails to give satisfactory service even though every operating precaution is taken in an effort to prolong refractory life, it will usually pay to take a good look at the design of the furnace and the furnace walls. In many cases, slight changes may produce real savings in longer wall life. In other cases, extensive furnace changes may be justified as the only solution.

Changing burner location or direction of flame travel to avoid direct action against the brick is a minor change that may pay for itself rapidly. Powdered-coal or oil burners placed too close to the side walls subject the refractories to extreme temperatures and the fluxing action of the ash. Distance between burner and backwall should be sufficient to keep the backwall out of the zone of greatest heat liberation. Try applying a thin coating of high-temperature bonding mortar; it will adhere strongly to the brick and will reduce penetration by the gases and molten ash.

If powdered-coal burners are improperly placed, brickwork around the burner opening may be worn away or slag may drop on a portion of the burner opening, deflecting the flame and causing other parts of the brickwork to be fluxed and eroded.

Changing Wall Construction

It may be possible, in some furnaces, to make changes in wall construction that will relieve severe operating conditions. The life of walls subject to high temperatures may be prolonged by making provision for ventilation or water cooling. This applies particularly to walls exposed to high temperature on both sides. Increasing lining thickness and redistributing the loading will help where the bearing ability has been reduced by deep softening resulting from high furnace temperatures. In some cases, reducing insulation thickness, by lowering the temperature of the cool side of the brick, will produce the same effect as thickening the wall.

Major changes in furnace design, such as increasing the volume of the combustion chamber, changing its shape, or altering the general construction, require serious consideration and it will usually pay to get expert advice.

In considering the advisability of these changes or changes in operating practice aimed at making furnace walls last longer, remember that the saving is much greater than just the cost of the brick and its installation. The need for furnace repairs or complete relining means costly shutdowns and loss of output, usually at a time when steam is badly needed. It's hard to put a price on reliability and continuity of operation, but it bulks large in the consideration of any operating problem.

CORRECTION

In the article, "Condensing Turbine Drives Ammonia Compressor", page 519, September *Power*, the turbine should have been credited to Terry Steam Turbine Co., instead of General Electric.

Operation and Control of Superposed Turbines

With many new top turbines in the initial operating stage, this article is a timely discussion of the problem of control and some of the means employed to avoid turbine outage

By C. B. Campbell
Westinghouse Electric & Manufacturing Company
South Philadelphia Works

EXTENDING and modernizing existing power plants by superposing high-pressure, turbine-generator equipment has become quite common practice in the past few years. In such cases, a large increment of power is generated with highly efficient noncondensing turbines expanding steam down to the original-station header pressure. It is doubtful whether the investment can be justified on the basis of the gain in station efficiency alone, unless an increase in plant capacity is necessary. Several good papers have been published dealing with improving plant performance by superposition, particularly by Zetterquist and Gove.[1] We are concerned now, however, with some of the equally important problems concerning mechanical aspects of installation and operation of superposed turbines.

[1] The Electric Journal, February, April, and June 1935.

The greatest increment of station capacity is obtained by adopting the highest practicable steam pressure. This has led to a common selection of 1200 lb at the turbine throttle, with a smaller number of 650-lb installations, and, more recently, consideration of pressures up to 2400 lb. 1200-lb steam pressure offers no serious obstacles as far as the turbine is concerned, and this level seems reasonable as the upper limit for the time being, as it does not require reheat with present steam temperatures.

The properties of common metals at 750 F are well known, and ample experience in actual plant operation supports these established properties. There is little experience in operation of boilers and turbines at 850 F, and almost none above 900 F. The physical properties of common carbon steels decrease very rapidly above 850 F, and "creep" is relatively rapid. To continue the use of well-known carbon-steel castings and forgings (with lower design stresses) has been done successfully up to 850 F, but is questionable practice for higher temperature as structures then become massive and introduce unequal heating with consequent indeterminate temperature stresses. This problem is now being solved by general use of comparatively new alloy steels, and by design of turbines for uniform heating and controlled expansion. Metallurgical developments of the past few years have been important factors in determining present steam temperatures which help justify superposition.

Speed of Rotation

Superposed turbines are designed for very large steam volumes at the throttle relative to their physical dimensions, because the turbine exhausts at moderately high pressures with correspondingly small specific volume of exhaust steam. For instance, a recent 50,000-kw, 1250-lb turbine, illustrated in Fig. 1, passes 1⅛ million pounds of steam per hour at full load, sufficient for a 150,000-kw condensing unit, yet exhausts through

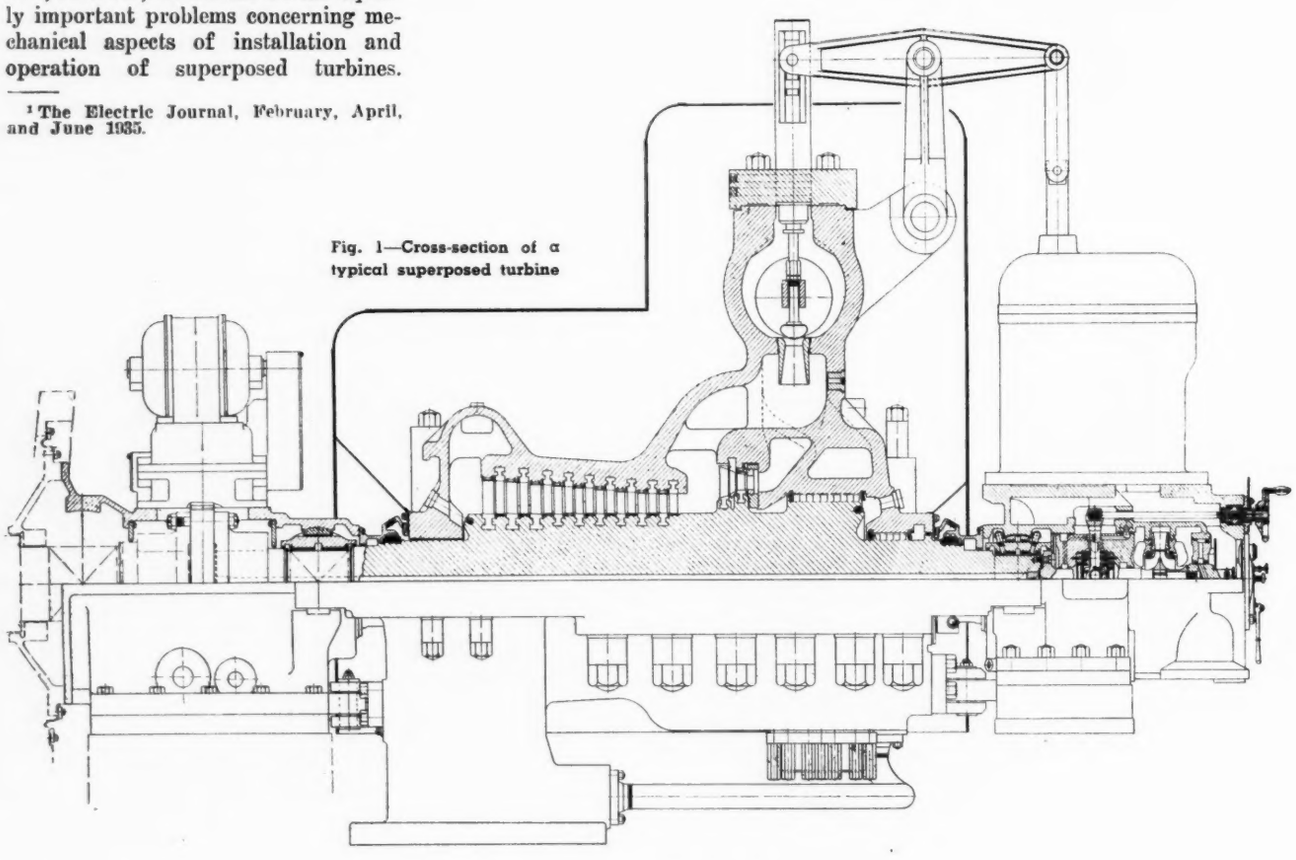


Fig. 1—Cross-section of a typical superposed turbine

a 30-in. diameter line at 340 lb. The small volume of exhaust steam is of great importance in the design of the turbine as it makes possible the use of 3600-rpm units driving 2-pole generators, without departing from established blade and mechanical details. With high steam temperatures, it is particularly desirable to design the turbine for the highest rotative speed possible (3600 rpm for direct-connected, 60-cycle generators) to reduce physical size and mass and therefore the possibility of distortions.

General Design of Turbine

The turbine shown in cross-section, Fig. 1, is typical of the construction of 1200-lb Westinghouse superposed turbines. Steam is admitted through seven governor-controlled inlet valves, opening in series. The seventh inlet valve opens in case of temporary overload, or reduced steam pressure at the throttle, or at full load in case of fouling of the blading and obstruction of the steam path. This valve admits steam directly to the reaction blades. At rated load the normal reaction inlet pressure will be approximately 950 lb.

The 1200-lb turbines of few years ago had but one or two governor-controlled inlet-valve points, as they were looked upon as "base load" units and little attention was given to their partial load performance. They were also small capacity units commonly installed with one high-pressure boiler from which they took all the steam generated. Reduced turbine efficiency due to throttling at partial loads would have resulted in high exhaust-steam temperature but for the drop in throttle steam temperature at reduced boiler rating, and the fact that throttle steam temperatures were then only in the 750-F class.

The modern superposed turbine operates with steam up to 950 F and the capacity has been increased to a point requiring two or three boilers per turbine. Therefore, the turbine may operate at partial load with one or two boilers out of service and the remainder steaming at full capacity and delivering steam at full temperature. Thus, there is need of sustained high turbine efficiency at partial load to avoid excessive exhaust-steam temperature, and multiple-inlet-valve control is the logical solution.

Steam chest and control valves for this service present quite a problem. Single-seated valves can more readily be made and kept tight, than can double-seated valves. Compared to the usual double-seated valves and their cages, there is less chance of their sticking, an important consideration at high temperature. Resistance to steam cutting of valves and seats requires the best of materials; various grades of stainless steels with Stellite trim appear to be satisfactory. Valve lifting rods, which must pass through close-fitting bushings, must be made of materials highly resistant to galling at high temperature. High-carbon, high-chromium rods in nitrided bushings have been found satisfactory. Many other combinations were eliminated in laboratory wear tests.

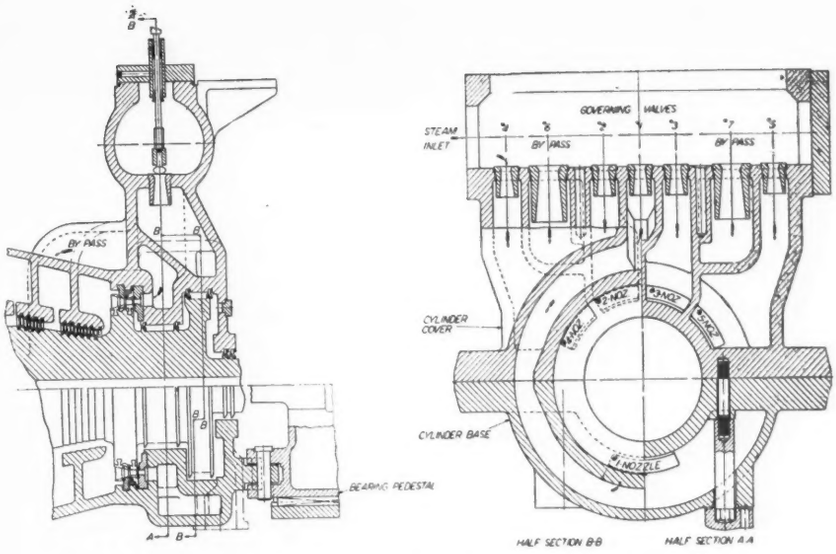


Fig. 2—Arrangement of steam passage in high-pressure end of turbine cylinder

In the design of turbines for high temperature service, it is particularly necessary to provide uniform heating of the cylinder to avoid troublesome distortions. A method used in the Westinghouse turbine is to locate the first nozzle group in the cylinder base and supply steam to it from the first governor-controlled valve through a cored annular passage extending entirely around the inlet end of the turbine cylinder. In this manner, the cylinder is heated around the full circumference when any steam is being supplied. This is illustrated by Fig. 2.

Limiting Capacity at 3600 RPM

Unlike the condensing turbine, where limiting capacity is determined by maximum practicable dimensions of exhaust-end blading, the superposed turbine at 3600 rpm is limited in capacity either by maximum possible generator rating or by the practical limit of steam flow for which a suitable control system can be built. Two-pole, 3600-rpm generators are now available with internal ventilating fans up to 31,250 kva rating with air cooling, and up to 62,500 kva, hydrogen cooled.

As previously stated, a control system has been built for 1⅛ million lb-per-hr steam flow at 1250 lb, 950 F. At present it appears that this could be extended to 1½ or 2 million pounds per hour, if desired, still at 3600 rpm.

The reason for thinking of a limiting steam flow as associated with rotative speed is the effect of speed on the inertia of the rotating mass. For instance, taking again the superposed 3600-rpm turbine-generator with full-load steam flow of 1⅛ million lb per hr, the combined turbine and generator has only about 3% of the inertia of the rotor of an 1800-rpm condensing turbine-generator passing the same amount of steam. To obtain satisfactory stability of the control system, particularly for synchronizing, the small unit demands extreme sensitivity and speed of governor response.

Governing System

The control system used on the Westinghouse superposed turbine is fully hydraulic. It is shown schematically in Fig. 3. The main centrifugal pump for supply of both lubricating and valve-operating oil is mounted directly on the turbine rotor. It pumps oil at about 125-lb pressure. Oil is delivered from main reservoir to pump suction by submerged ejectors, which, for each unit volume of oil supplied to them at pump discharge pressure, deliver 2 to 2½ volumes of oil to the pump suction. Excess oil over that required to operate the ejectors is available for lubrication of bearings and operation of valves. As the only connections between the turbine and the oil reservoir are through pipes, the tank can be located, within reason, where most convenient below the turbine-room floor. Advantage is usually taken of this fact to put the tank well away from hot steam pipes.

A very small amount of oil from the main pump passes through an orifice to a special impeller which holds a pressure of about 40 lb at

normal speed, but varies as the square of the rotor speed. The variations in this pressure, acting on a spring-loaded bellows, supply the primary controlling impulse to the governor. In the diagram, Fig. 3, this part of the mechanism is indicated as the "governor transformer." The name comes from the fact this mechanism transforms relatively small impeller discharge-pressure changes into changes of about five times the magnitude with no sensible lag. The small relay above the bellows is rotated by an oil jet to remove friction.

The transformed oil pressure acts on a springloaded bellows, and through a double relay system controls the flows of oil to and from the main governor valve operating piston to change the steam flow. The complete governor is assembled in a single housing supported by the thrust-end bearing pedestal. By laboratory test and field application, it has been demonstrated to be a very sensitive, rapid, and powerful apparatus well adapted for variations to permit pressure as well as speed control.

Overspeed Trip

Once the turbine is under load, a sluggish governor would probably fit in quite satisfactorily as it will usually be desirable to let the superposed equipment run along at fixed load without responding to minor system frequency changes. Sensitivity is required, however, in order to synchronize, and also by the common requirement that the turbine-generator be capable of instantaneous loss of full load without tripping the overspeed stop.

This latter requirement presents a more difficult problem with superposed turbines than for condensing units. In one case, the initial rate of acceleration of the rotor with full valve opening at the instant of releasing full load was calculated as 21% per second, compared with about 7% for an 1800-rpm condensing unit with the same steam flow. This means that the valves must close in about one-third the time available for the condensing turbine-generator. If tripping under these extreme conditions must be avoided, we recommend that overspeed stops be set about 12% above normal speed on superposed turbines of large capacity, instead of the customary 10%.

Constant and Variable Exhaust Pressure

There are two fundamentally different methods of operating the superposed turbine with existing equipment. Most common is the scheme of exhausting into the old steam-header system and retaining part of the old boiler plant in operation. The turbine then operates with practically constant exhaust pressure at all loads. The other plan is to tie the new unit definitely to old condensing turbines, and obtain a cross-compound combination with one or more condensing elements. The steam inlet valves on the condensing turbines are then left wide open, steam-flow control is entirely on the high-pressure-turbine governor, and the receiver pressure then becomes a variable, dependent on the steam flow. This system requires complete superposition in the plant, or isolation of part of the condensing capacity of the plant from the old header system. Where circumstances permit, improvement in efficiency can be obtained, due to reduction in throttling losses, and due to generating more of the total load on the more efficient new unit.

Exhaust-Pressure Regulator

It has been our experience that the specifications for practically every superposed turbine require that it be supplied with an exhaust-pressure regulator; this is a control device that reacts on the main governor in normal operation causing the governor to pass whatever amount of steam is required to maintain constant exhaust-header pressure. Such control finds common application on non-condensing turbines supplying exhaust steam for manufacturing process, or heating, but it should not be used to control a steam-header pressure if there are boilers in operation with automatic-control systems supplying the same system. This would almost certainly result in instability between the two systems of control and unnecessary fluctuation in load on the more efficient high-pressure equipment.

The exhaust-pressure regulator may still serve a useful purpose. If it is adjusted to a pressure slightly in excess of normal exhaust pressure, it will be inoperative under normal conditions. However, if load and steam demand of condensing units should decrease to a value less than that supplied by the superposed turbine, the corresponding rise in exhaust pressure will reduce steam flow before the exhaust safety valves open. Such control is obtainable by proper adjustment of standard exhaust-pressure regulators.

The exhaust-pressure regulator, adjusted for a pressure just under the exhaust relief valve setting, is useful with variable exhaust pressure operation. When one of the condensing turbines normally taking steam from the superposed turbine is out of service, the pressure control automatically limits steam flow to the maximum capacity of remaining low-pressure units.

Turbine Ventilation

Based upon tests made during astern operation of marine propulsion turbines, an investigation has been made of the probable temperature changes in case a superposed turbine were driven at normal speed by the generator acting as a motor and with no steam passing through the blading. Obviously, the losses of blades rotating in dense steam would all be absorbed in heating the turbine. This condition might arise because of the sensitive exhaust-pressure control shutting off steam flow, or from the accidental tripping of the throttle valve after synchronizing. The pre-

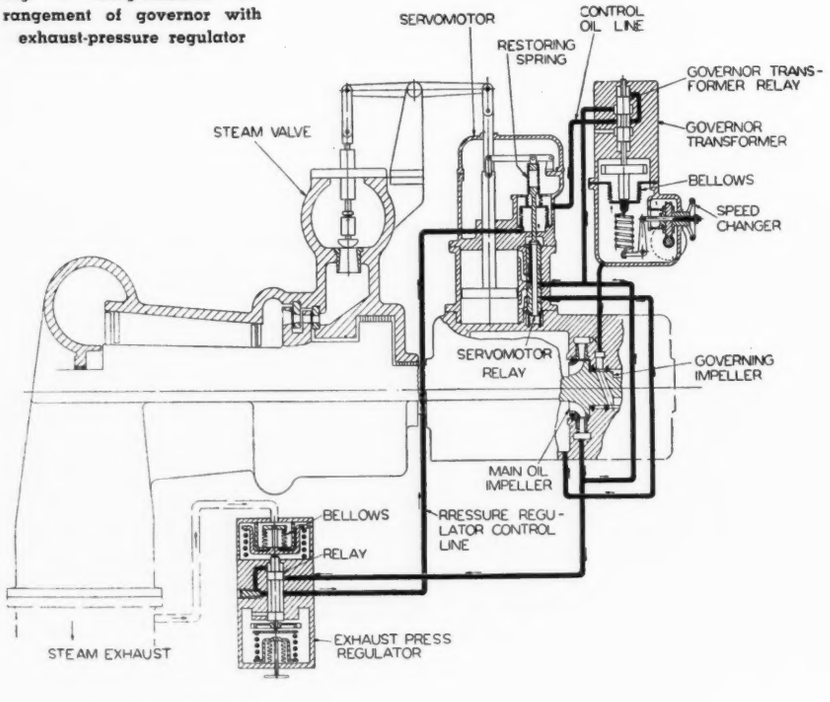


Fig. 3 — Diagrammatic arrangement of governor with exhaust-pressure regulator

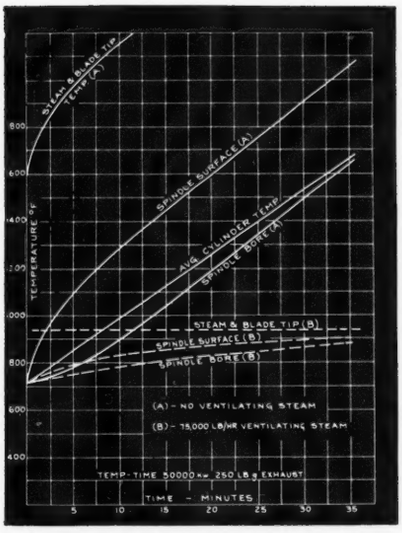

STEAM & BLADE TIP TEMP (A)
SPINDLE SURFACE (A)
AVG CYLINDER TEMP
SPINDLE BORE (A)
STEAM & BLADE TIP (B)
SPINDLE SURFACE (B)
SPINDLE BORE (B)
(A) - NO VENTILATING STEAM
(B) - 75,000 LB/HR VENTILATING STEAM
TEMP-TIME 50000 KW 250 LB EXHAUST
TIME - MINUTES
TEMPERATURE °F

Fig. 4—Predicted temperature-time curves for: (A) no ventilation, (B) 50% no-load steam for ventilation

dicted temperature-time relationship for a typical case is shown by Curve "A" in Fig. 4, assuming the average steam temperature in the turbine is 725 F at the instant of shutting off steam. The entrapped steam and the blade tips will very quickly increase to something near 1600 F, as they have little heat-storage capacity. There will then be sufficient temperature gradient to transfer heat through the blading and cylinder equal to the rate at which heat is generated. The temperature of all parts will continue to increase but at a lower rate. While this analysis is not highly accurate, it shows the probability of quickly attaining dangerous temperatures.

Curves "B" of Fig. 4 show the temperature-time relationship in case the flow is decreased to about 50% of no-load steam. Entrapped steam and blade tip temperatures increase quickly to about 940 F. Cylinder temperature increases slowly and at no time becomes dangerous, most of the loss being removed by the steam.

Ventilating Connections

Ventilating lines with orifices have therefore been provided on superposed turbines, connecting the inlet side of the throttle valve to the first nozzle bowl in the cylinder base. This line has a manually-operated valve for closing during shutdown periods. The orifice is designed for not over 50% of no-load steam flow. As it connects to the first nozzle group, it has no effect on the efficiency of the turbine. Such protection is not required on a turbine operating with variable exhaust pressure. A much simpler method would be to trip the generator automatically from the line when it motored and allow it to slow down, but practical operating methods usually exclude such an arrangement.

In the operation of superposed turbines exhausting into lower-pressure boiler-header systems, abnormally low exhaust pressures sometimes occur, due, for instance, to sudden load increase on the condensing units, or from low-pressure boiler trouble. An exhaust-pressure control would open the steam valves wide in response to the exhaust pressure drop or the steam valves might already be wide open carrying full load. Reducing exhaust pressure increases the Btu/lb of steam available for work in the superposed turbine rapidly and may result in serious overload of the generator unless the steam flow is reduced. The most important result is a marked increase in stress in the last rows of blading, over which all of the increased pressure drop occurs. Such turbines are designed for safe operation with full steam flow and about 20% reduction in exhaust pressure, but as such operation overloads the generator, the unit should be equipped with electrical means of backing off automatically on the governor speed changer motor to reduce steam flow enough to hold the load down. This can be accomplished with standard equipment available. Turbine stresses are satisfactory under any reduced exhaust pressure, providing the rated generator output is not exceeded.

Exhaust Steam Temperature

Turbine exhaust steam temperature should be about the same as low-pressure boiler steam, and in any case not greater than that which the older condensing units can use safely, unless temperature is reduced after leaving the high-pressure turbine by desuperheating. There are two cases to consider; first, the most common one in which automatic pressure-reducing and desuperheating equipment parallels the turbine to permit the high-pressure boiler plant to operate while the superposed turbine is shut down, and, second, the case in which the boiler plant and turbine are considered as a unit and there is no provision for a bypass steam path.

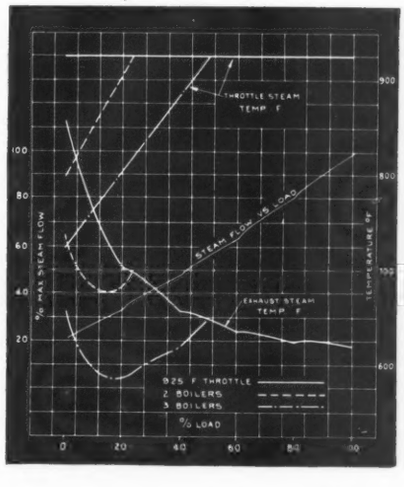
In the first case, the boiler plant may be steaming at maximum capacity while the turbine is being started, most of the steam passing through the reducing valve. In this case the turbine is operated at light load with full steam temperature. Curves in Fig. 5 show the expected exhaust-steam temperature and flow plotted against output for the typical case of a 50,000-kw turbine operating with 1200 lb, 925 F, and 250 lb exhaust. At no load the steam consumption is approximately 21% of maximum flow and the exhaust steam temperature is 857 F, only 68 F lower than throttle temperature. The curve shows that exhaust temperature drops rapidly with increase in load, and that above 50% load the temperature variation is small. For starting or operating at light loads, presuming that the temperature is too high for the condensing turbines, the alternatives are to desuperheat steam at throttle or at exhaust, lower boiler output or adjust dampers to decrease steam temperature, or arrange exhaust piping to mix with cooler steam before reaching any low-pressure turbine.

Compound Operation

Conditions are improved if the boiler rating follows the turbine steam demand when there is no bypass reducing valve, boiler and turbine operating as a unit. This is shown also in Fig. 5. In the case assumed there are three boilers, each having damper control to permit obtaining full steam temperature, 925 F, at 60% rating and above. The lowest curve shows the relationship of load and exhaust-steam temperature when all three boilers are supplying steam to the turbine. Other curves show starting up with two boilers, also a considerable improvement over using 925 F steam at low loads. With three boilers, exhaust steam temperature is fairly constant at all loads. This problem arises only when operating with constant exhaust pressure. With cross-compound turbine arrangement and low receiver pressure at light load, exhaust temperature will also be comparatively low.

It has not been the purpose of the foregoing to say that the modern superposed turbine is accompanied by dangerous or tricky hazards. The problem is a little out of the ordinary, requiring intimate coordination between turbine and boiler operation. A serious attempt has been made to anticipate and provide for many contingencies that may arise in routine operation, so that nothing can occur to damage the equipment.

Fig. 5—Typical exhaust-steam temperatures at various outputs



Speaking of Power

This is convention season for engineers. Late August and early September saw the diesel meeting at Penn State and the big N.A.P.E. annual affair (St. Louis). October features the Power Show in Chicago, a Fuels Conference in Pittsburgh and the national Fall Meeting of the A.S.M.E. at Erie, first of its kind. After a little rest in November we shall have the annual A.S.M.E. meeting in December.

My week in St. Louis (N.A.P.E.) left me with several impressions, relating mainly to license laws, heat, air conditioning and education. As to the first, N.A.P.E. hasn't got its license-law problems licked yet, but its committees are realistic and learn by experience. They are now making real progress with state laws for plant operators. . . . A year ago many of the operating men were greatly concerned because the wording of professional engineering laws seemed to threaten their jobs and titles. This situation is now well in hand in most states, with professional and operating engineers cooperating to protect the rights of all concerned.

. . . *Convention season

. . . Heat and air conditioning weren't on the official St. Louis program, but nature supplied the heat (plus humidity). Many air-conditioned places of assembly, dining and amusement proved that the engineers (in St. Louis and elsewhere) are staging a major victory of man over nature.

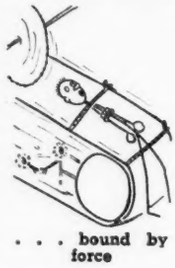
. . . a major victory

Future generations will bless the engineers for this—if they happen to think of it.

In the matter of education, I'm not so sure that the operating engineers have found the real answer. Education is becoming more and more essential to the individual as a means of advancement. Most of the needed information is available at moderate cost in existing books, periodicals and study courses. Yet much of it never reaches its destination inside the human skull—leaks in the transmission system, or else the valves are closed. . . . I am gradually veering around to the opinion that it would pay many local organizations of practical engineers to arrange for extension courses conducted by professors from nearby technical schools. Even this won't work unless the "prof" is one of those rare men who can get down off his high horse and talk as man to man. . . . Another absolute essential is individual work on problems by the engineers taking the course. You can't learn engineering by listening to lectures—not in a thousand years. No problems solved, no education; take it or leave it! Lectures, however, are generally preferred as more restful to all concerned. Few are willing to sweat for an education.

. . . off his high horse

These rambling comments on education lead directly to another hobby, better cooperation between technical and practical engineers, better mutual understanding and more effort by each group to acquire some of the virtues of the other. . . . To bring this right out in the open, I'm going to quote three viewpoints from three letters just received. First is the slant of many technically trained engineers, as expressed by a well-known consulting engineer: "Power-plant designers for industrial processes are still bound by the operating force and must always keep in mind the people that will run the plant. One of the greatest obstacles to progress is the operating engineer whose mind is closed to progress, and who will not learn how to operate.



. . . bound by force

Few plants have enough instruments and controls for uniform good operation, but there is no use making records that are not used in the operation of the plant. It looks as though the modern operating man is still to be developed. We have him in the utilities. We should have him in the industrials."

Next I bring you the views of a technically trained engineer in general charge of power for a very large industrial establishment: "More and more technically trained men seem to be getting into management jobs. This will mean a better chance for the industrial power engineer to install the best equipment available and to employ the proper type of technical men for operating control."

And, just as the cheering for the technical man rises to the skies, I slip in these words from a boiler inspector: "Twenty-five years ago the average chief went around in dirty overalls and carried a wrench. He was an expert in detecting anything seriously wrong, but had little patience with the white-collar "efficiency" man who tried to tell him how to run his plant. Now we are heading too far in the other direction. I meet increasing numbers of "supervising" or "superintending" engineers. They are 100% on efficiency calculations, but often sadly lacking when it comes to handling common-sense problems of safety and plant maintenance. In the long run, efficiency suffers, as you might expect.

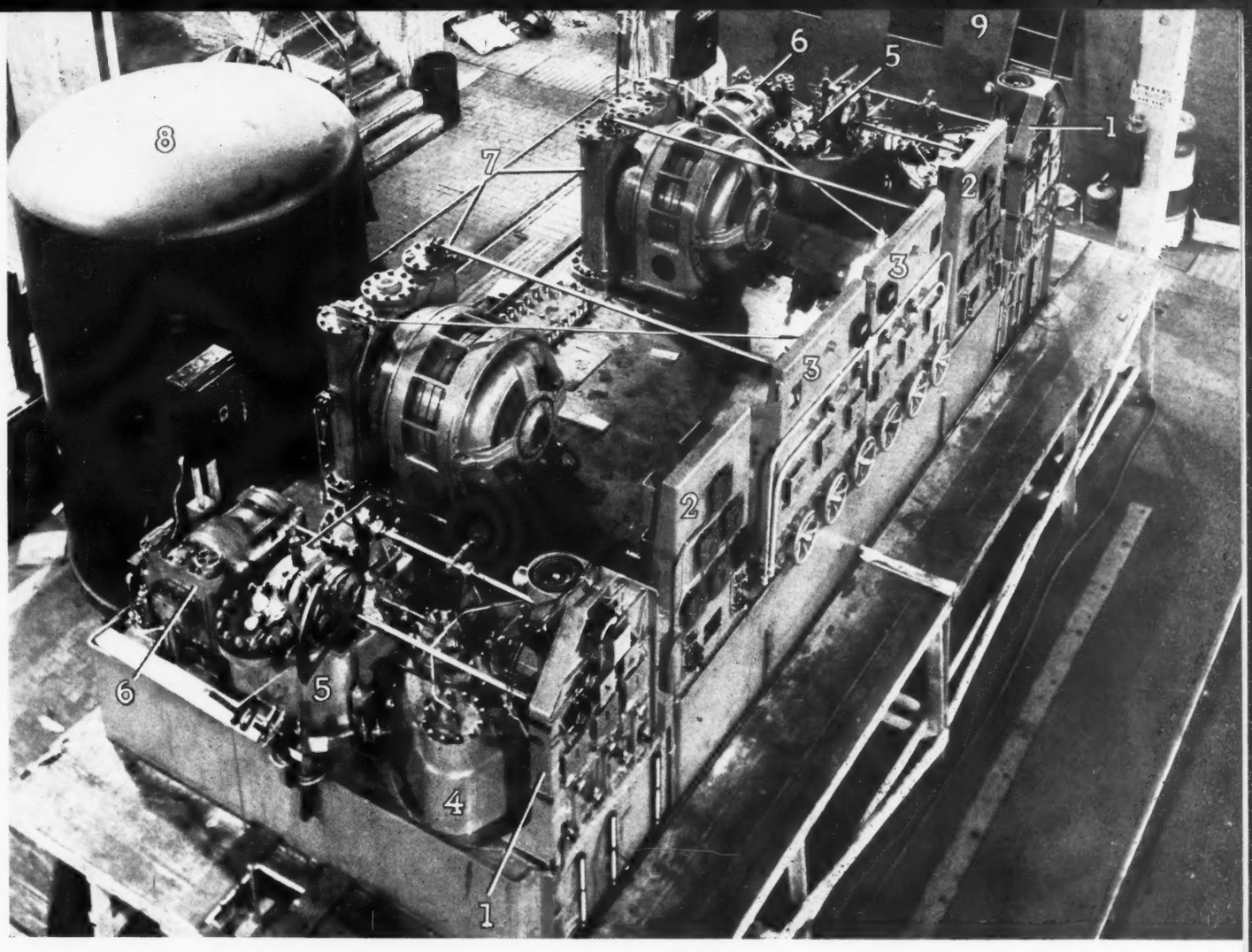
. . . 25 years ago

"One recent visit showed badly fouled turbine blades with a resulting high steam rate. The new-style chief had insisted on carrying a high alkalinity in his boiler water to reduce corrosion. He forgot that exceeding the happy medium would cause dirty steam.

"Let's have a few more chief engineers who can graduate from college and then spend a few years learning the ropes in actual operating and repair work before assuming charge and telling others how to do it."

Here, then, are all the makings of a nice little argument. It seems clear to me that both the practical and technical groups have something to learn and that a little mutual education should come next on the program.

PHIL SWAIN
Editor



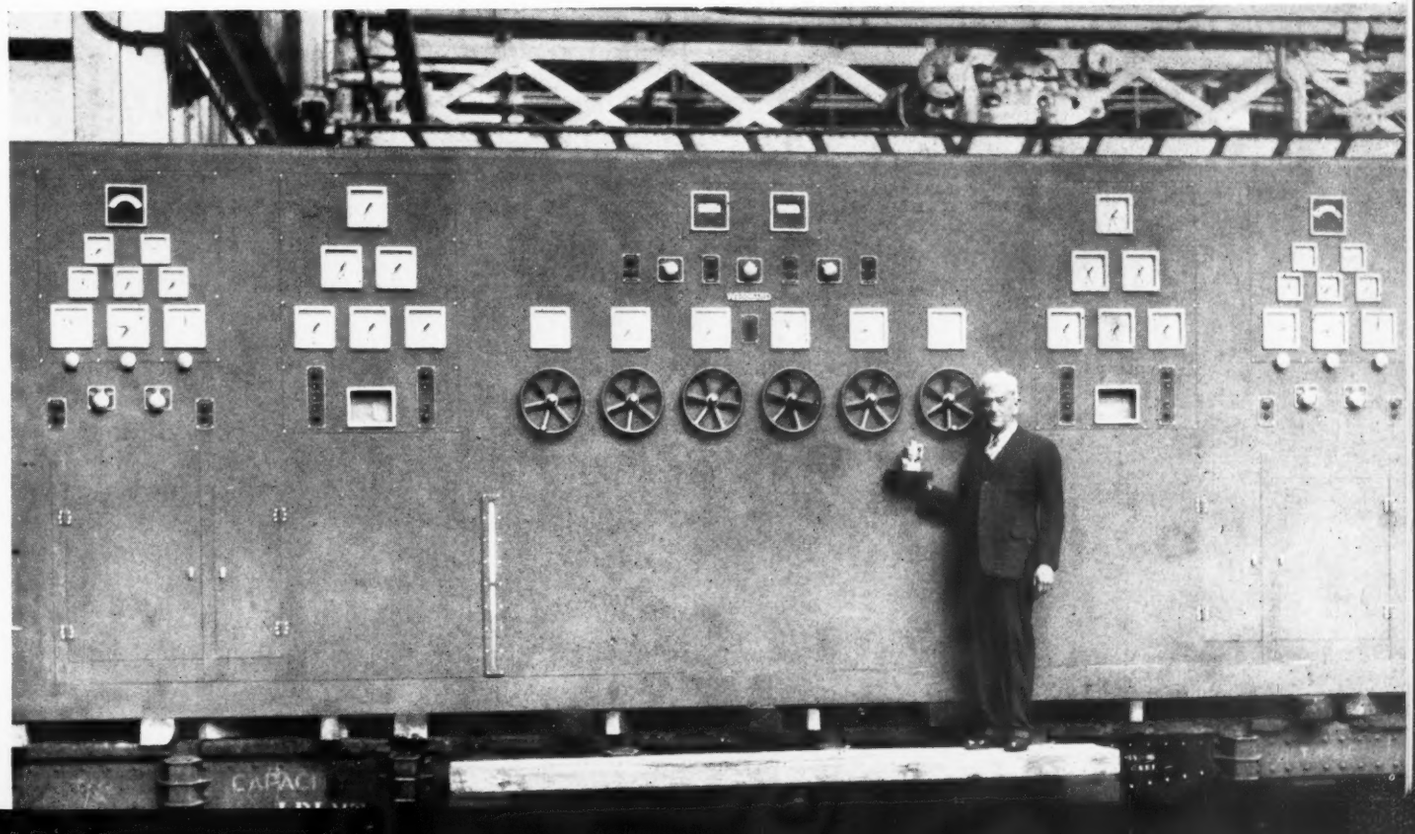
BELOW: Mr. Woodward holds an airplane governor in front of its gigantic contemporary, the twin governing equipment for two 60,000-hp Kaplan turbines (under 60-ft head) being installed in the Bonneville power house on the Columbia River

Bonneville Governors

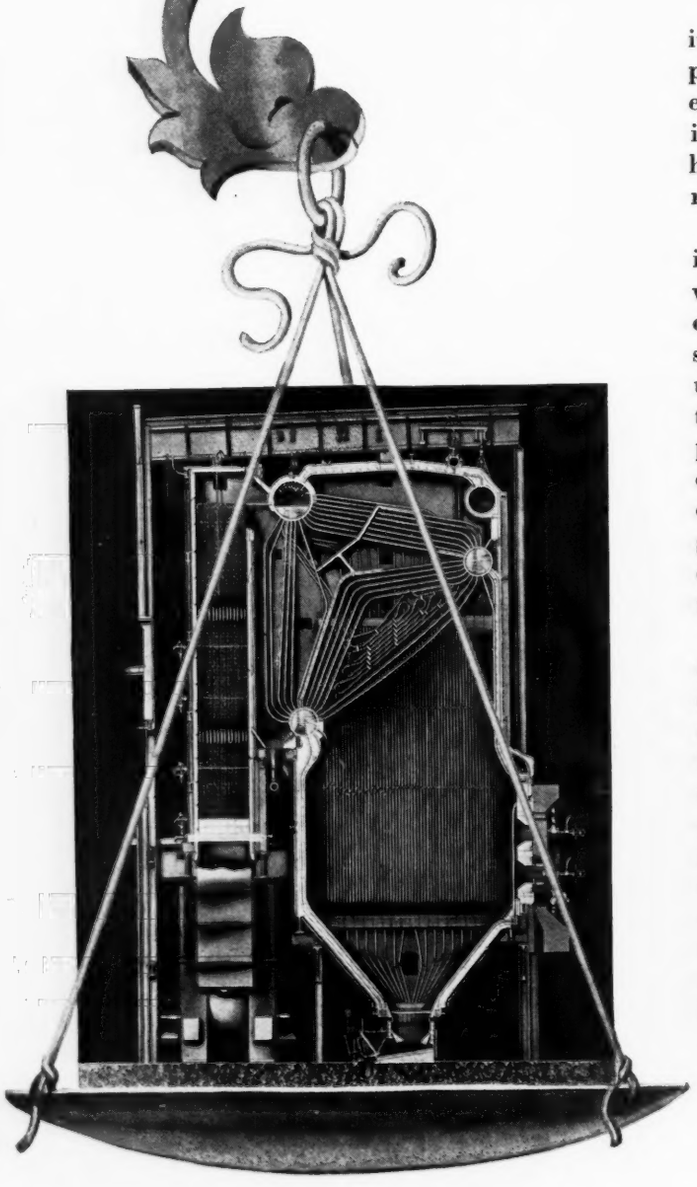
ABOVE: 1—Actuator controls, 2—Gage and indicator columns, 3—Pump-control columns, 4—Gate-control relay valves, 5—Blade-control relay valves, 6—100-gpm pumps, 7—600-gpm pumps, 8—Pressure tanks, 9—cabinet

The governing unit is 23 ft long, 9 ft 6 in. wide, and 8 ft high, and weighs approximately 70,000 lb

Photos courtesy Woodward Governor Co



RILEY



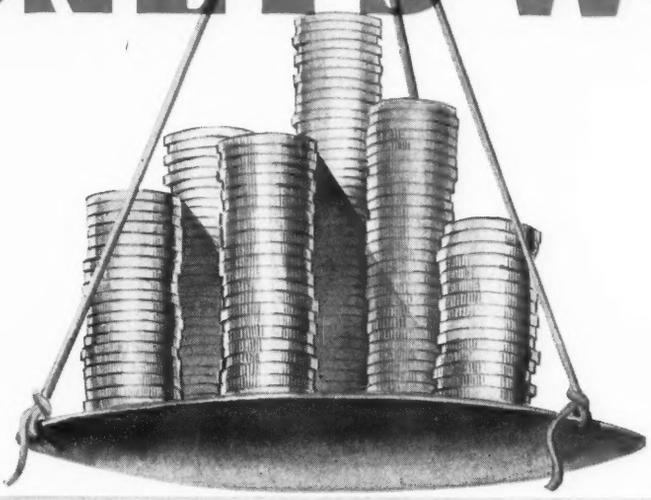
Today when a steam generating unit is installed, it is purchased on the basis of being capable of producing a certain amount of steam at a guaranteed efficiency. If the unit is capable of actually producing a greater amount of steam or of operating at higher than guaranteed efficiency, these excesses represent a real dollars and cents bonus.

The Riley Stoker Corporation is justified in stating that "Riley certainly gives you your money's worth" because invariably purchasers find that they can comfortably operate their Riley equipment substantially in excess of Riley's guarantees. The positive unrestricted circulation and other design characteristics of Riley Boiler equipment, together with the policy of not making guarantees up to the very limits of the equipment's capabilities assure the purchasers of Riley equipment a definite bonus above Riley's guarantees. Actual bonuses occurring on a number of recent installations are shown in the accompanying table.

The plus values of Riley equipment are not confined to capacity alone. You will also find that efficiency guarantees made by Riley are invariably exceeded. Plus values of equal importance are also found in the materials and workmanship of Riley units. Values which become very evident after years of operation through lack of maintenance and operating difficulties. Riley engineers have always been first of all quality minded. Evidence of this characteristic is shown by the careful attention given to minute details of design and construction which is readily apparent by a careful investigation of existing Riley units.

Riley certainly gives you your money's worth by providing worth-while plus values in their equipment.

certainly gives you your MONEY'S WORTH



That the engineering profession has come to realize that Riley certainly gives you your money's worth and to fully appreciate the many plus values of Riley equipment is evidenced by the definite swing to Riley with the consequent tremendous increase in Riley sales volume. Sales of Riley equipment have increased steadily since 1931, with sales in 1937 running several times greater than in the boom year of 1929.

EXAMPLES OF PLUS VALUES IN RILEY UNITS

	Guaranteed Capacity lbs./hr.	Actual Operating Capacities Obtained lbs./hr.
Kalamazoo Vegetable Parchment Co.	150,000	175,000
Lynn Gas & Electric Co.	205,000	260,000
W. Va. Pulp & Paper Co., Williamsburg	72,500	100,000
Upper Michigan Power Co.	90,000	120,000
Whippany Paper Board Co.	66,000	80,000
West Virginia Pulp & Paper Co., Covington	375,000	425,000
Standard Oil Co. of California	125,000	146,000
Pennsylvania Sugar Co.	250,000	320,000
Collins & Aikman Co.	45,000	56,000

	Guaranteed Capacity lbs./hr.	Actual Operating Capacities Obtained lbs./hr.
Celanese Corporation	150,000	175,000
Arnold Print Works	110,000	125,000
Ames Worsted Co.	70,000	Over 85,000
University of Minnesota	100,000	125,000
Forstmann Woolen Co., Passaic	60,000	80,000
Brehm & Stehle Co.	30,000	Over 50,000
Pet Milk Co.	20,000	29,000
North Dakota Power & Light Co., Beulah	56,000	70,000

You owe it to yourself and your company to thoroughly investigate Riley equipment. A call or letter to Worcester, Mass., or to the nearest Riley office will provide you with additional information about Riley products.

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RILEY

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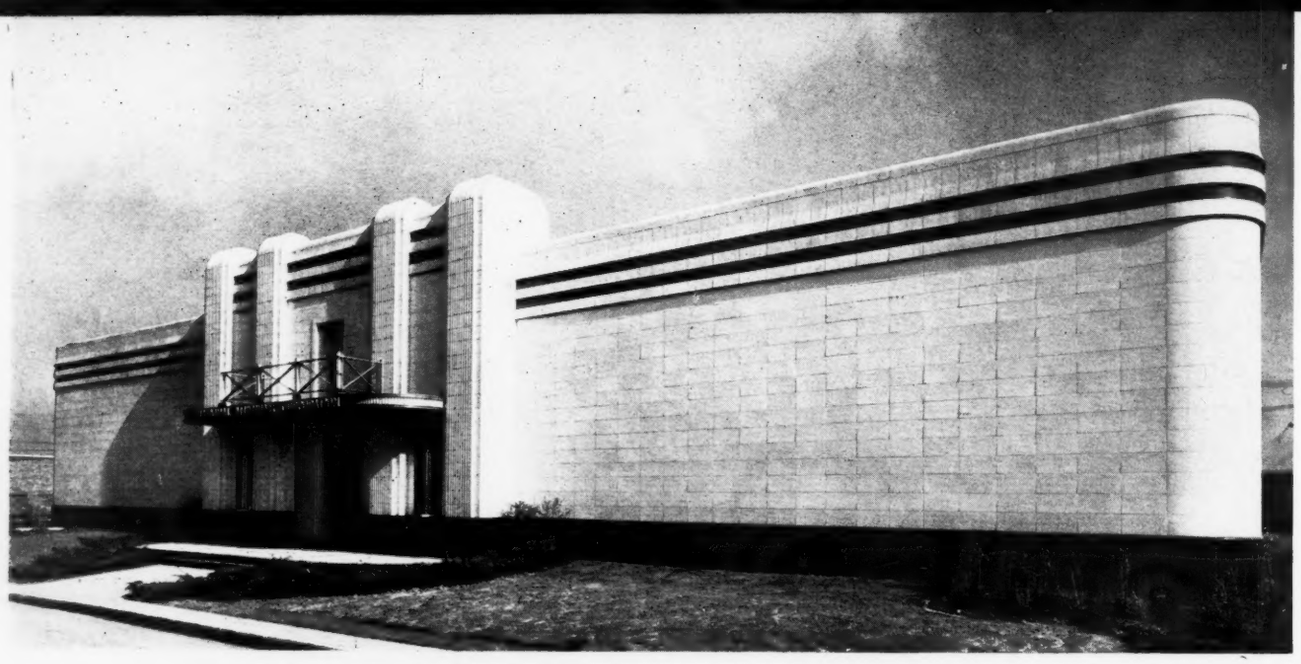
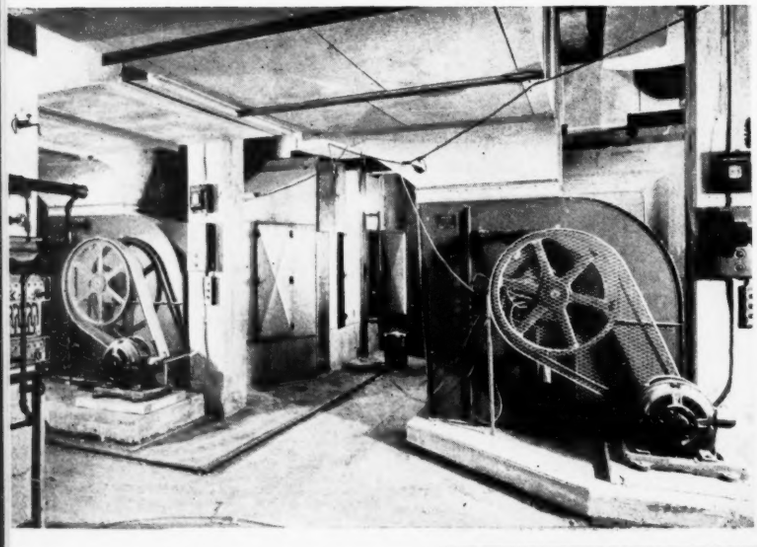
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS



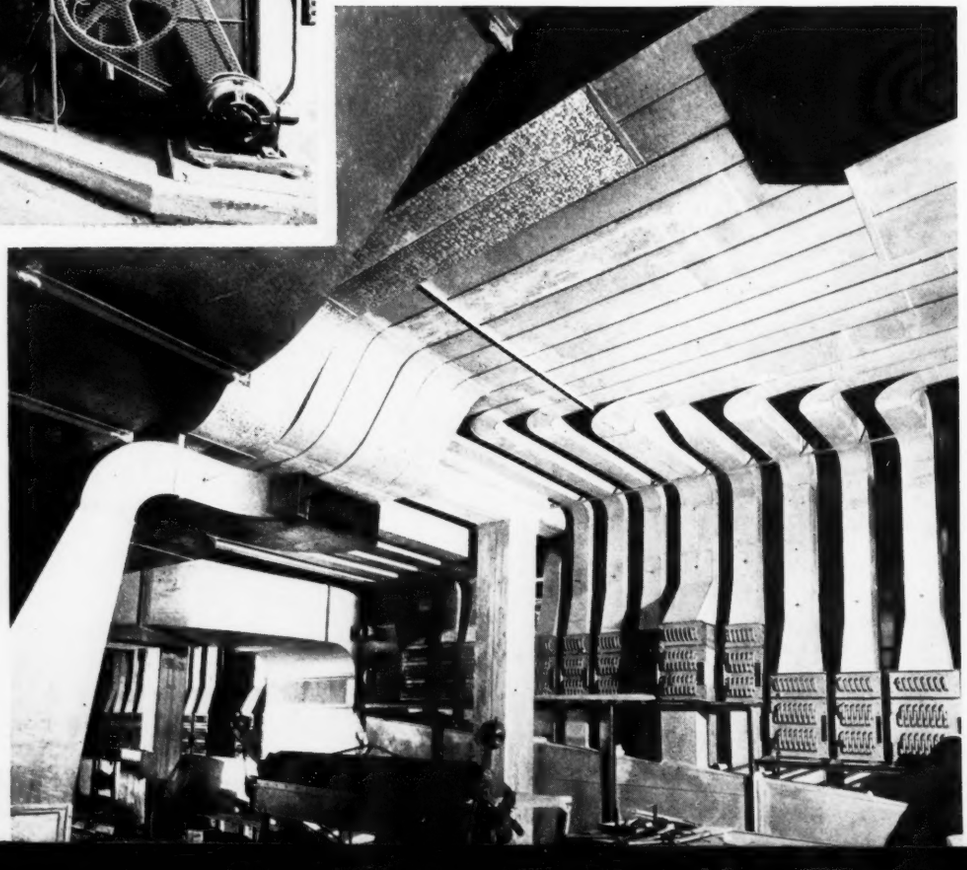
Mixing the yellow tint of the incandescent lamp and the blue tint of the mercury-vapor lamp makes artificial daylight and enough heat to balance small losses through the windowless walls. Even in extremely cold weather, cooling is required for interior rooms, while others are being heated. Well water, at 53 F, and a unique conditioning system do the trick

No Windows

Eliminating windows cuts off noise and dust, puts an end to drafts and discomfort from sun heat, permits uniform illumination at all times and in all parts of the building, lowers construction costs and cuts heat losses—therefore no windows for National Aluminate's new laboratory and office building

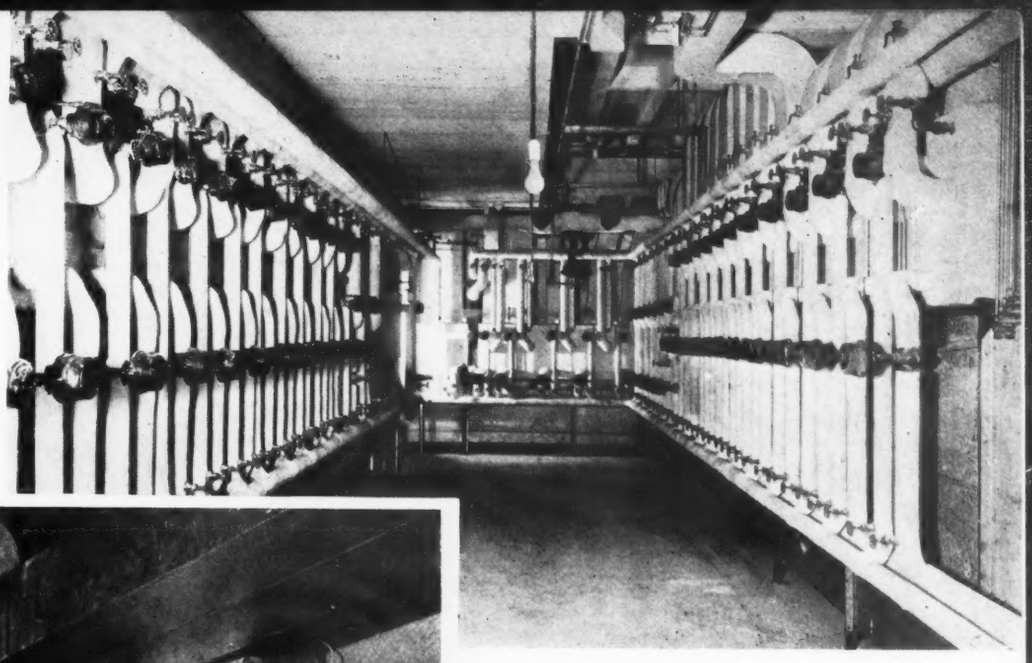


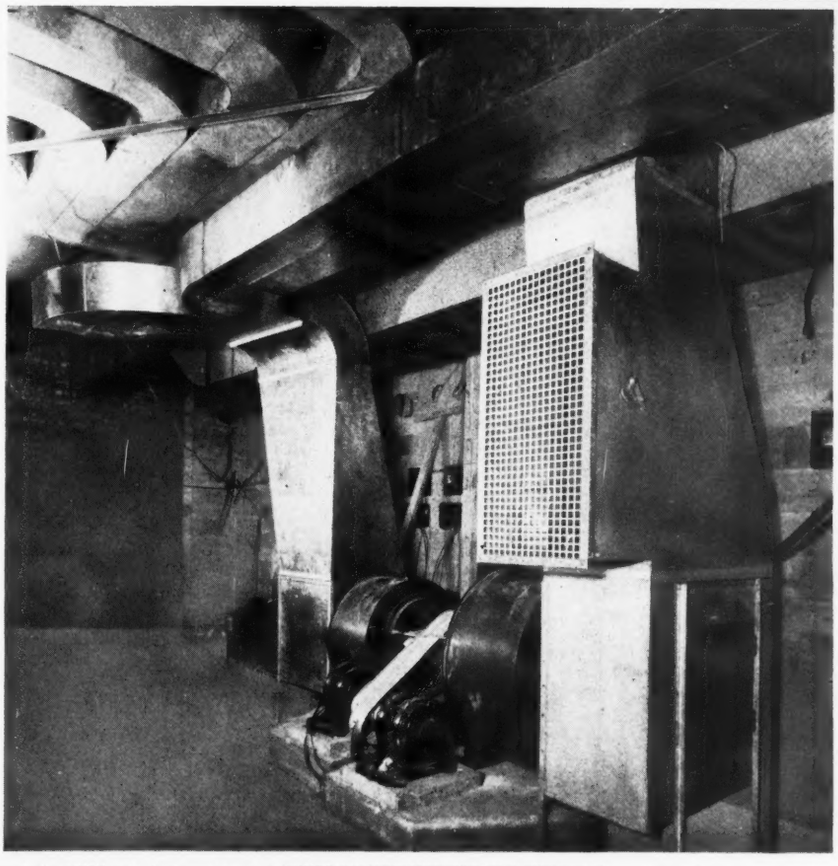
Emergency air requirements are insured by splitting the load between two similar systems, cross-connected. Tempered fresh air and recirculated air are cleaned in automatic oil filters, humidified in winter, and blown into the two main ducts by the fans shown



An individual branch duct for each of the 63 air-conditioned spaces solves the problem created by varying heat losses, heat emissions and personal tastes. The amount of sheet metal duct work per cu ft of building volume probably constitutes a record

Hot and cold water for the coils in each branch duct is piped from the plant across the street, which houses the two 10-hp deepwell pumps and the heat exchanger for water heating. Hot- and cold-water control valves on each set of coils are controlled by thermostats in each air-conditioned space. Humidity is regulated centrally

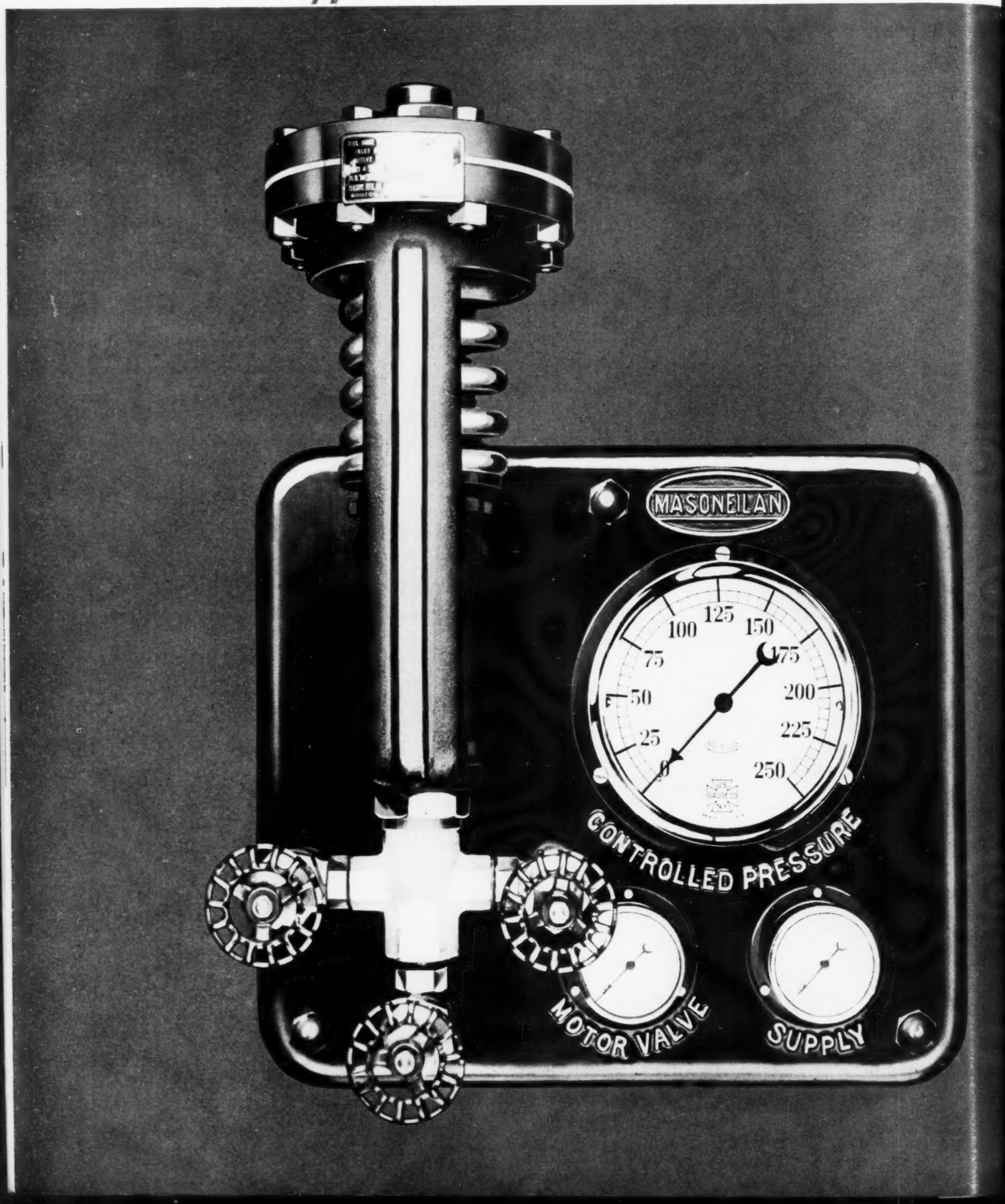




Partitions and doors are tight, so excess air is vented to spaces above the corridor ceilings and pulled out by roof fan ventilators. The fans shown exhaust noxious fumes from the laboratories and keep air in the toilet rooms clear

Life in a windowless laboratory looks pleasant. Plenty of uniform, restful light even on cloudy days, cool comfort on sweltering days, and no one misses the view over Chicago's industrial district

THE *Syncromaster*
PRESSURE CONTROLLER



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Simplified—Economical—Full Throttling

EXACT CONTROL

SIMPLICITY is the engineering key-note of the Syncromaster—designed especially to eliminate the disadvantages common to other types of hydraulic-operated controllers. A minimum of equipment without complicated hook-up, chains, weights or levers provides refined throttling operation at a minimum cost. The Syncromaster is compact, rugged and essentially foolproof. Operating pressure is obtained from ordinary city or other external water supply of 20 to 150 pounds pressure; or under favorable conditions the Syncromaster may be operated by water pressure from the high pressure side or by steam. Since the operating pressure *bleeds only when the control valve diaphragm pressure is reduced* it is very economical to operate.

The Syncromaster may be used anywhere accurate, positive reducing or back pressure regulation is required. Typical applications include desuperheating service, turbine or bleeder make up systems, feed and oil pump service, heating and evaporating systems, primary and auxiliary steam lines and many others. The Syncromaster is particularly adapted to high pressure service where large volumes of gas, air, liquids or steam must be handled under fluctuating demand.

FEATURES

Hydraulically Operated for stabilized operation and economy.

Sensitive to slightest pressure changes.

Positive in action under fluctuating demand.

Easily Adjusted to maintain any pressure within its range.

Convertible for back-pressure or reducing service with either direct or reverse acting control valve.

Convenient—may be mounted on wall or panel for remote control, or, if desired, directly on control valve.

Throttling Operation for smooth, exact control.

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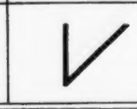
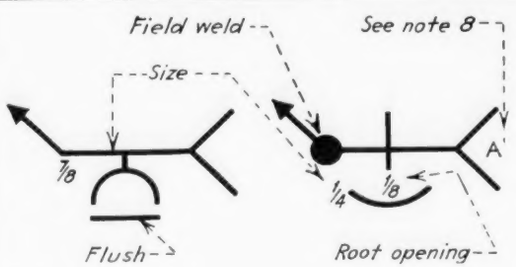
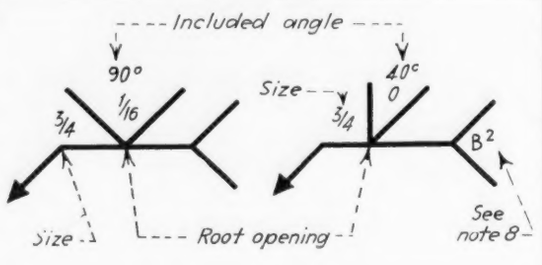
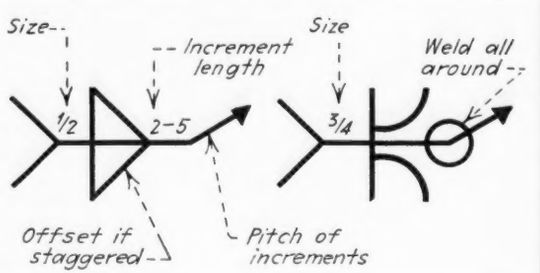
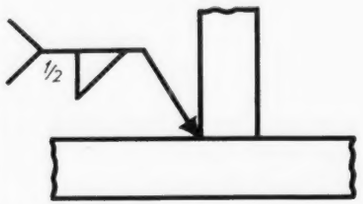
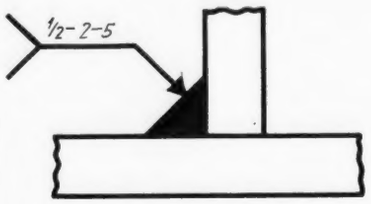
Standard Fusion-Welding Symbols

TYPE OF WELD										
BEAD	FILLET	GROOVE					PLUG AND SLOT	FIELD WELD	WELD ALL AROUND	FLUSH
		SQUARE	V	BEVEL	U	J				
										

NEAR SIDE	FAR SIDE	BOTH SIDES
		



See Note 2



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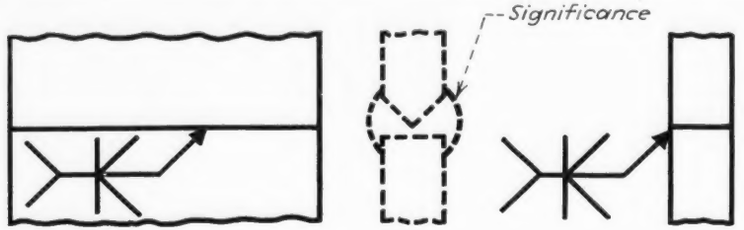


See Note 7

FOR CONVEYING full welding information from designer to workmen, the American Welding Society has evolved a set of standard symbols. These allow complete welding information to be placed on drawings. Picture writing, they show graphically the type of weld required, and a large amount of information is conveyed accurately by this shorthand system using only a few simple lines and numbers. Supplementary symbols may be developed for special purposes by the user.

NOTES

1. In plan or elevation, near, far and both side locations refer to nearest member parallel to plane of drawing and not to others farther behind.
2. In section or end views only, when weld is not drawn, the side to which arrow points is considered near side.
3. Welds on both sides are of same size unless otherwise shown.
4. Symbols govern to break in continuity of structure or to extent of hatching or dimension lines.
5. All welds are continuous and of user's standard proportions and all except V- and bevel-grooved welds are closed unless otherwise shown.
5. When welds are drawn in section or end views, obvious information is not given by symbol.
7. In joints in which one member only is to be grooved, arrows point to that member.
8. Tail of arrow used for specification reference.

Note: All dimensions are in inches.

FRICTION CLUTCHES—II

Here are described several designs of expansion, compression, cone, coil and spiral friction clutches

FRICTION CLUTCHES have been developed in many types and are used for a wide variety of purposes in mechanical power-transmission applications. In September *Power,* page 500, single- and multiple-disk axially operated and single-disk radially operated types were described. This article covers the other designs.

Fig. 13 shows a clutch cutoff coupling of the expansion type. Friction band *B* is forced out against the inside of drum *D* which is keyed on the left-hand shaft. Hub *H* is keyed to the right-hand shaft and carries one side of a vee that fits against the inside of friction band *B*. The right-hand side of the vee is carried freely on the hub *H*, and is connected to the operating mechanism. When lever *L* is forced outward to engage the clutch, the cam on its end forces the right-hand side of the vee and friction band *B* to the left against the left-hand side of the vee, and band *B* is expanded against drum *D* to connect the two shafts together.

A double friction-band clutch of the expanding type is shown in Fig. 11. The outer band *B* is forced out against a drum as in Fig. 12, and the inner band B_1 acts on ring *R*. The bands are applied by two cone-shaped rings that are forced between them by the operating mechanism. This design gives considerably greater capacity for a given drum diameter and length than does the design of Fig. 13.

An expanding-type clutch designed with the friction band in four sections, but making practically 100% contact with the friction drum, is shown in Fig. 12. Wedges *W* fit between the ends of the friction shoes. These shoes are held in a released position by springs *S* and are applied when the clutch-operating mechanism forces wedges *W* out between the friction shoes, expanding them against the friction drum.

The clutch of Fig. 14 comprises drum *D*, central hub *H*, and expanding ring *R*. The expanding ring is fixed to the hub at *A* and is therefore driven by it. Engagement of the clutch is by a cone forced in between the ends of fingers *F*. At their upper ends, the fingers are so shaped that they expand ring *R* when their lower ends are separated.

Several compression-type clutches have been developed. In these the clutching element contracts on a drum, as in Fig. 15. In this design the pulley has drum *D* cast to its spokes. This drum is surrounded by the friction element, which is similar to a band brake with a wood-block lining. The clutch is engaged by moving lever *L* to the right, which causes the friction element to contract and grip drum *D*. The design shown is of the power-takeoff type, but these clutches are also arranged for cutoff coupling service.

Another type of compression coupling is shown in Fig. 16. Drum *D*, keyed to one shaft, contains a bearing for the end of the other shaft and is surrounded by band *C*. A cas-

Fig. 11—Cutoff-coupling-type clutch having double-expanding friction band

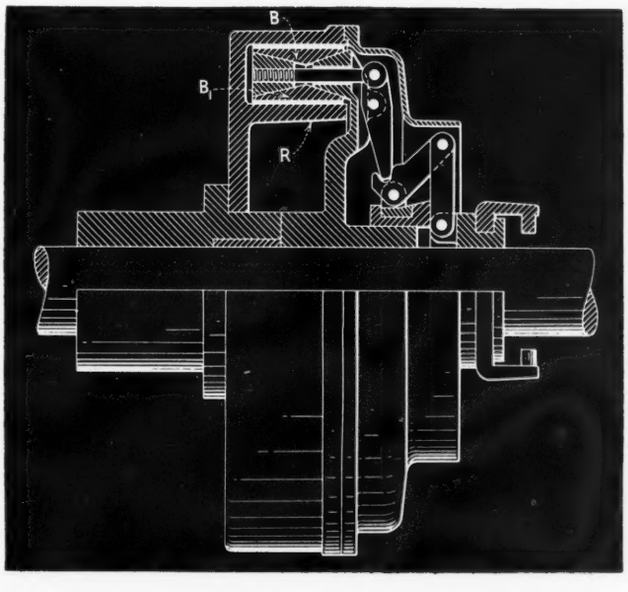


Fig. 12—Expanding-type clutch with friction band in four sections

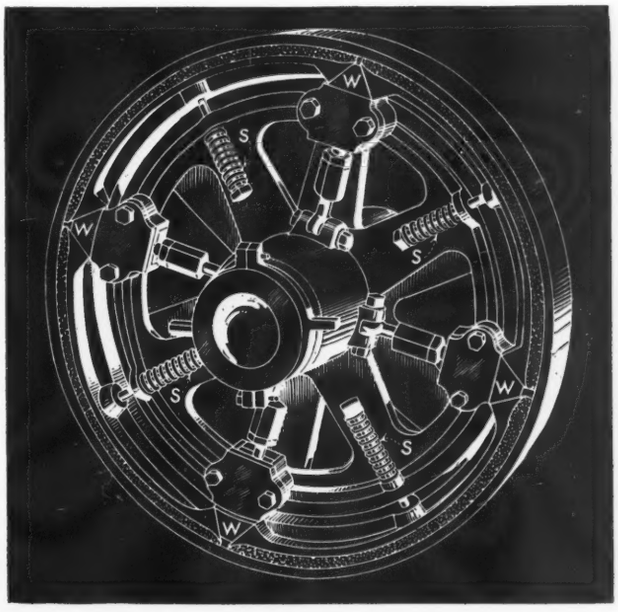
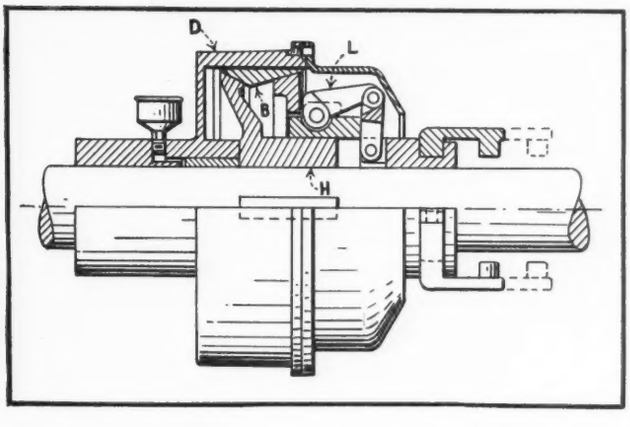


Fig. 13—Cutoff-coupling clutch of the single-friction band, expanding type



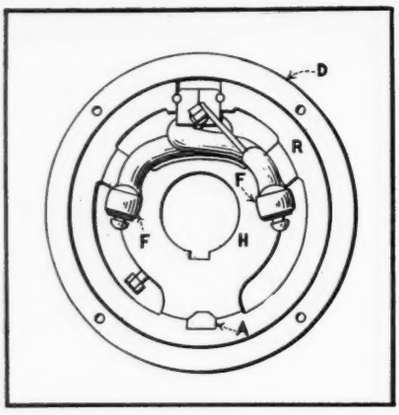


Fig. 14—Totally inclosed, expanding-ring-type clutch of compact design

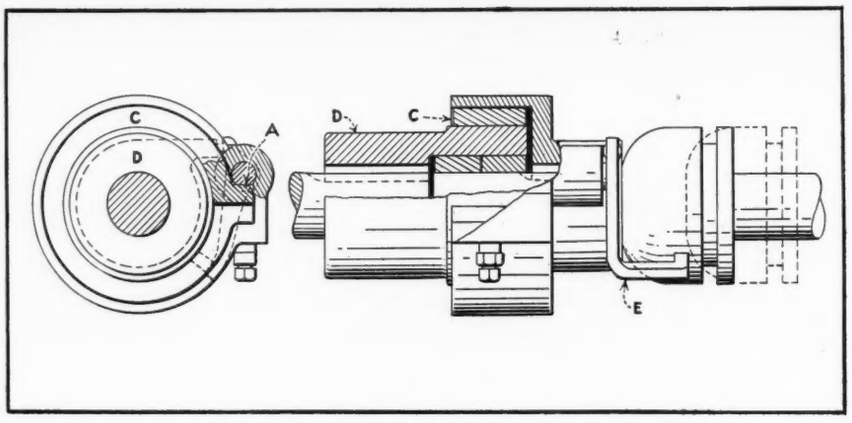


Fig. 16—Cutoff-coupling compression-type clutch

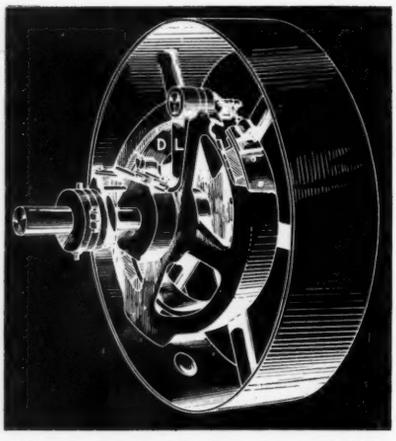


Fig. 15—Compression-type clutch in which the friction element is similar to a band brake with a wood-block lining

ing outside serves to support it and the operating lever. Engagement of the clutch is by a crank E turned through a small arc by a cone pushed under it. The end of crank E engaged with friction band C has a flat side, as at A. When A is turned counterclockwise, it closes band C onto drum D to connect the driven and driving parts of the clutch.

New Principle

The clutch of Fig. 18 operates on a new principle. It is made with quadruplex friction elements and with duplex elements. Friction elements comprise pairs of self-aligning conical metal rings, each pair telescoping over the other with a wedging action by means of an axial shifting force. This clutch is filled with oil, consequently friction surfaces are lubricated. A good lubricant on suitable metallic surfaces has great film-forming ability. These films are embodied in and firmly attached to the metallic friction surfaces. During engagement of the clutch, they become very thin and of uniform thickness because of the self-adjusting features of the friction elements.

In the top half of the figure, the clutch is engaged, in the bottom half released. Friction rings connect to driving hub H and driver casing C by splines in a rotational direction only. Play in the splines permits adjustment of friction rings and also a slight misalignment between driving and driven shafts to protect them from severe stress and the bearings from overloads.

Pressure to engage the clutch is produced by an axial force applied to operating ring R, which, through rods S, causes the toggle mechanism to move from the position in the lower part of the figure to that in the upper half. This action causes pressure plate P to force the friction rings together under higher pressure. When the pressure plate is released to disengage the clutch, the friction rings separate and release the two shafts. This clutch is available in sizes up to several thousand horsepower.

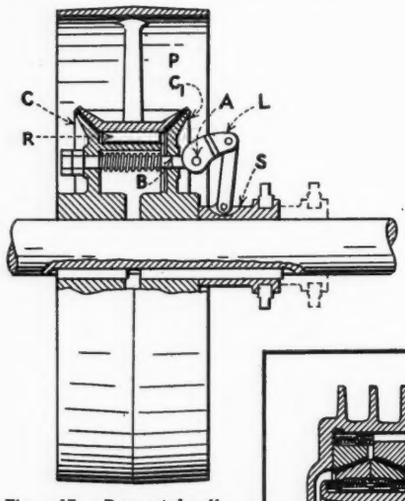


Fig. 17 — Power-takeoff friction clutch of the cone type built into a flat-belt pulley

Cone-Type Clutch

One form of what might be considered a cone clutch is shown in Fig. 17. Left-hand cone C is keyed to the shaft and right-hand cone C_1 is held by a spline, but free to move axially. Pulley P is supported between the two cones on a friction ring running on roller bearing R. Operating lever L is pivoted at A on bolt B. When lever L is moved upward, by moving sleeve S to the left, as in the figure, its eccentric-shaped end forces the two cones together and causes them to grip the friction ring on the pulley.

A twin-cone, cutoff clutch, Fig. 19, has drum D keyed to the left-hand shaft and has a vee on its inner periphery. Left-hand friction surface F is part of the hub keyed to

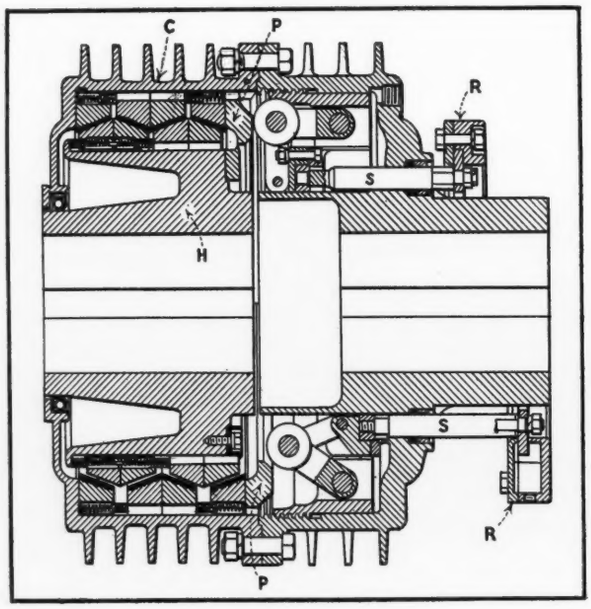


Fig. 18—Friction elements in this clutch comprise pairs of metal self-aligning conical rings

the right-hand shaft. Right-hand friction element F_1 connects to the toggle-operating mechanism and is free to move axially under its control. Operating lever L pivots at P with its ends connected to the movable friction element and the operating mechanism by toggle joints. When the operating collar is moved to the left, as in the figure, lever L is forced into the position shown and the two friction surfaces brought into contact with the vee attached to the drum D, thus engaging the two halves of the clutch.

A coil-type friction clutch is shown in Figs. 20 and 21, which comprises three principal members: drum D, usually forming the driving member; coil C, and plate P, to which the coil is fastened. In the cutoff-type clutch, Fig. 21, the drum is keyed to the driving shaft and plate P keyed to the driven shaft. Drum D runs in a pilot bearing in plate P to insure shaft alignment. This drum is selected cast iron, chilled and polished, while coil C, Fig. 21, is made of carbon steel of high tensile strength. The cross-section of the coil tapers from one end to the other. Its small end or tail is free when the clutch is released, the large end being permanently attached to P of the driven member.

When the clutch is released, as in Fig. 21, sliding collar S, cod ring R, and the drum inside the coil are free to rotate with the driving shaft. To engage the clutch, collar S is moved against the mushroom pin in lever L. The lower end of L connects to the small end of coil C at A, therefore as the upper end of L is forced to the left, its lower end tightens the coil on the drum to engage the clutch. When the small end of the spring is brought in contact with the driving drum, it gradually tightens the coil until coil and drum become practically integral. When running released, coil and drum must be lubricated like any journal bearing. Clutches of this design have been built in capacities up to 8,000 hp at 50 rpm.

Spiral-Spring Clutch

In the disk-actuated spiral-spring clutch, Fig. 22, drum D is keyed to the drive shaft and is free to rotate when the clutch is released. The driven part of the clutch includes casing C connected to a hub keyed to the drive shaft. Surrounding D is a flat spiral spring S, the left-hand end of which connects to C and the right-hand end to a friction disk F. When the shifter sleeve O is pressed under wedge W, it moves upward against the ball bearing and forces F against the end of D. As the friction disk turns with the drum, it tightens the flat spiral onto the drum, as a rope is tightened around a capstan, and the clutch is engaged to accelerate the load. When the operating sleeve is withdrawn to release the clutch, S_1 forces W down and disk F is forced away from the drum. The ball bearing between wedge W and friction disk F permits easy operation of these parts.

In this clutch, practically all power is transmitted by the spiral, the sole duty of the friction disk being to contract the spiral to engage the clutch. A feature is small diameter for a given capacity. This clutch, however, like Fig. 21, cannot be used for reversing service. When such a clutch is ordered, the direction of rotation must be stated.

For information from which this article was prepared, *Power* is indebted to: Gustave Fast Engineering Co.; Fresh Flo Pump & Mfg. Co.; Muncie Oil Engine Co.; Western Engineering & Mfg. Co.; Kinney Mfg. Co.; Hanson Clutch & Machinery Co.; Edgemont Machine Co.; W. E. Caldwell Co.; McMahon & Co.; Joseph Reid Gas Engine Co.; Conway Clutch Co.; Hess-Snyder Co.; Fawick Manufacturing Co.; Webster Weller Mfg. Co.; Ayars Machine Co.; Gifford Wood Co.; and Farrel Foundry & Machine Co.

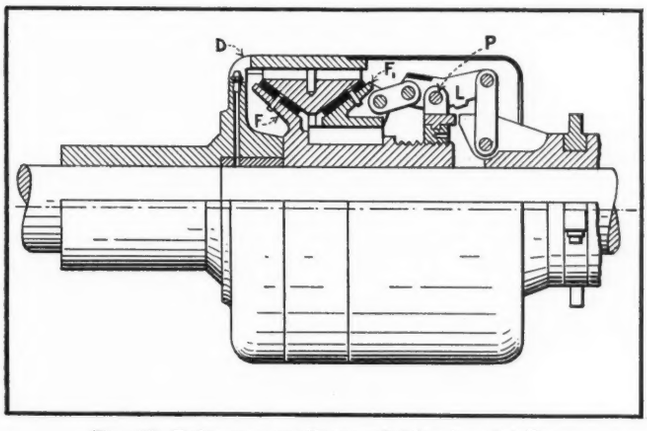


Fig. 19—Twin-cone cutoff-type clutch of a totally inclosed design

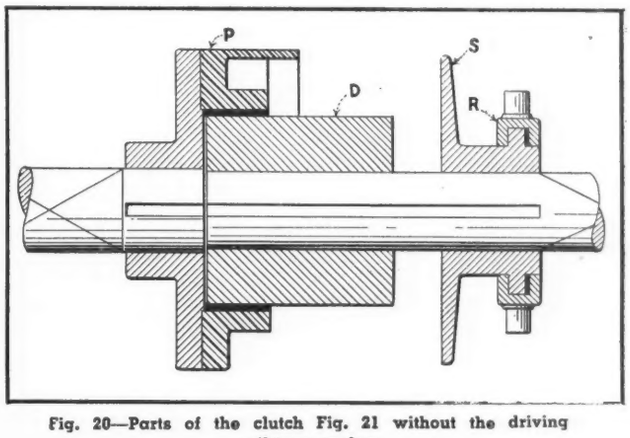


Fig. 20—Parts of the clutch Fig. 21 without the driving coil-type spring

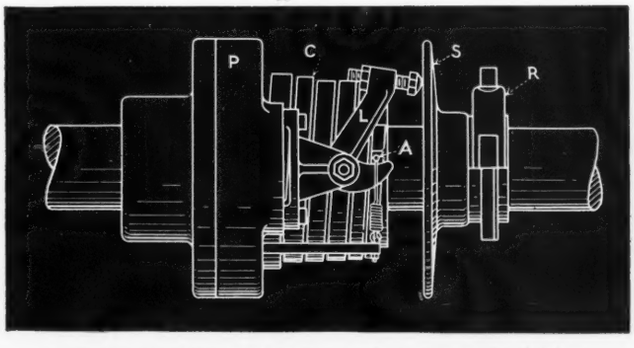


Fig. 21—A spring tightening on a drum forms the friction element in this coil-type clutch

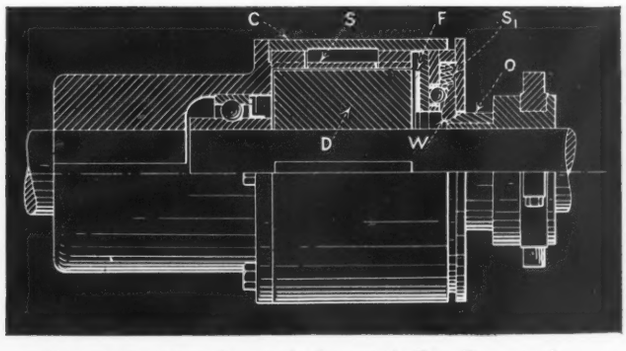


Fig. 22—In this coil-type clutch, practically all power is transmitted by a metal spiral

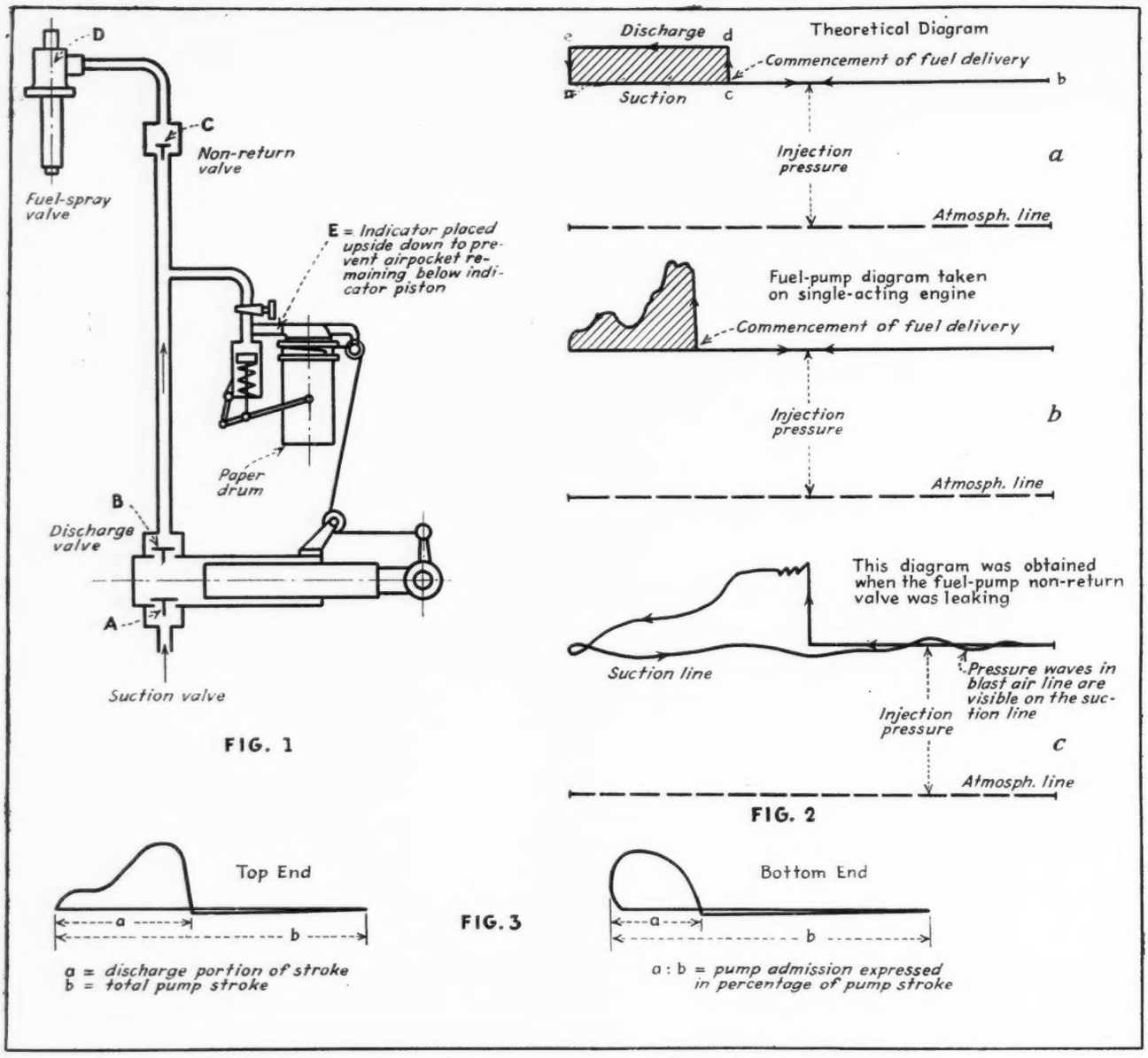


Fig. 1—Arrangement for an ordinary pv indicator on the fuel-pump line. Fig. 2—Some typical cards on an 800-hp air-injection engine. Fig. 3— Cards from a double-acting diesel

Indicator Checks Diesel Fuel Pump

Both delivery and misadjustment of fuel-oil pumps on air-injection diesels may be determined by this method, described by Standard Oil's chief engineer in the Dutch East Indies

By N. J. DeGeest, W. I.

Chief Engineer,
Standard-Vacuum Oil Co., Singapore

FUEL-OIL DELIVERY of power cylinders of air-injection engines can readily be determined with the ordinary engine indicator. As the fuel pump governs power developed, its delivery must be adjusted with greatest accuracy, even though the amount of fuel delivered at each injection is very small. Otherwise, certain cylinders will be overloaded.

Previously, the only control on load per cylinder was the indicator diagram. In order to establish whether all cylinders are giving the same horsepower, indicator diagrams taken from each cylinder must have the same area. Diesel indicator diagrams are not always trustworthy because they are so small, so engineers have been hoping to find a method by which deliveries of various fuel pumps can be established and compared.

The simplest, and one of the most accurate, methods (B. Louis) is to use the ordinary pv indicator, but to connect it into the pump-discharge line. It should be hooked between discharge valve *B* and non-return valve *C*, usually very near to the spray valve or atomizer. Valves should be provided on each discharge line so that the in-

dicator can be shifted to each in turn. The indicator drum is driven from the plunger of the pump from which fuel delivery is measured.

A theoretical diagram is shown in sketch *A*, Fig. 2. During the pump suction stroke, there will exist the injection pressure *a-b*, which remains unaltered during the entire period in which the suction valve is open, *b-c*. At *c* the suction valve closes and the pump begins to discharge, pressure in the discharge line rising to *d* because the fuel must open non-return valve *C*, Fig. 1. Pressure then remains constant until suction begins again. The ratio of the lengths of *a-b* and *a-c*, Fig. 2, give a clear picture of that part of the discharge stroke and should be the same for all cylinders.

This method gives true results only if the discharge line and the indicator are completely air vented. To prevent air from getting under the indicator piston, it is best to put the instrument on upside down.

Actual Diagrams

Naturally diagram form will greatly vary from the theoretical diagram sketched. Sketch *b*, Fig. 2, for example, shows a diagram from a single-acting engine. Pressure variations shown after the suction valve closes are due to the inertia of the oil mass to be delivered. Nevertheless, the point at which fuel delivery begins is clearly visible.

The same method can be used to determine faulty adjustments of fuel pumps. Diagram *C*, for instance, shows a leaking non-return valve. Pressure variations of the blast-air line are clearly visible on the discharge line during the suction stroke of the pump. Fig. 3 shows actual fuel-pump diagrams from an 8000-hp double-acting diesel, the left side showing the top end, and the right side the bottom end.

"Effective" fuel-pump stroke and required tappet clearances can be calculated when the hp rating and specific fuel consumptions of a certain engine are given. Adjustment of fuel-pump feed is done by alteration of the *active* part of the stroke. This can be obtained, for example, by a special construction of the operating mechanism of the plunger, but it has been found more practical not to alter *actual* pump stroke but to change its *active* or *effective* portion, depending on engine type. In air-injection engines, the moment and duration of injection are governed by the mechanically operated fuel valve. The fuel pump only takes care of admission of the correct quantity of fuel. The effective portion of fuel-pump stroke is altered as necessary by changing the time of closing the suction valve after the plunger has begun its stroke. These are calculated thus (Sothern):

Example I—A 2-cycle engine has a capacity of 500 hp per cyl and runs at 115 rpm. Fuel-pump plunger size has been calculated as 1 in. and minimum tappet clearance is given as $\frac{3}{4}$ in. Fuel specific gravity is 0.864. Then (assuming 1 lb fuel per b hp):

$$\frac{500 \times 1 \times 1728}{0.864 \times 62.5 \times 60} = 267 \text{ cu in. fuel per min}$$

"Full" fuel stroke thus must be:

$$\frac{267}{0.7854 \times 115} = 3 \text{ in.}$$

From the above it follows that the ratio of tappet clearance to tappet stroke is equal to the ratio of the *effective* delivery stroke to the *full* pump stroke, from which it follows that when tappet clearance is 0, effective stroke is 0, and if tappet clearance is $\frac{3}{4}$ in., effective delivery stroke is 3 in.

The ratio is the same for *any* required full delivery, therefore, the following equation holds good:

$$\frac{\textit{Tappet clearance}}{\textit{Tappet stroke}} = \frac{\textit{Effective stroke}}{\textit{Full stroke}}$$

Example II—When in Example I fuel consumption at 500 hp is 0.42 lb per b hp per hr, then tappet clearance should be:

$$0.75 \times 0.42 = 0.313 \text{ in.}$$

Example III—Find effective fuel-pump stroke and required tappet clearance when power is reduced in the above example to 250 hp, allowing a specific fuel consumption of of 0.45 lb per b hp per hr. Effective pump stroke required then will be:

$$\frac{250 \times 0.45 \times 3 \text{ in.}}{500 \times 1} = 0.675 \text{ in.}$$

and tappet clearance must be (from the formula at end of Example I):

$$X = \frac{0.675 \times 0.75}{3 \text{ in.}} = 0.168 \text{ in.}$$

Also, $\frac{0.675}{3 \text{ in.}} = 0.225$, which is the ratio of effective pump stroke to the full stroke, and therefore the ratio of tappet clearance to tappet stroke.

Example IV—Find effective pump stroke and tappet clearance when in Example III fuel consumption is raised to a 10% overload (550 b hp per cyl) allowing a fuel consumption of 0.44 lb per b hp per hr. Effective pump stroke will have to be:

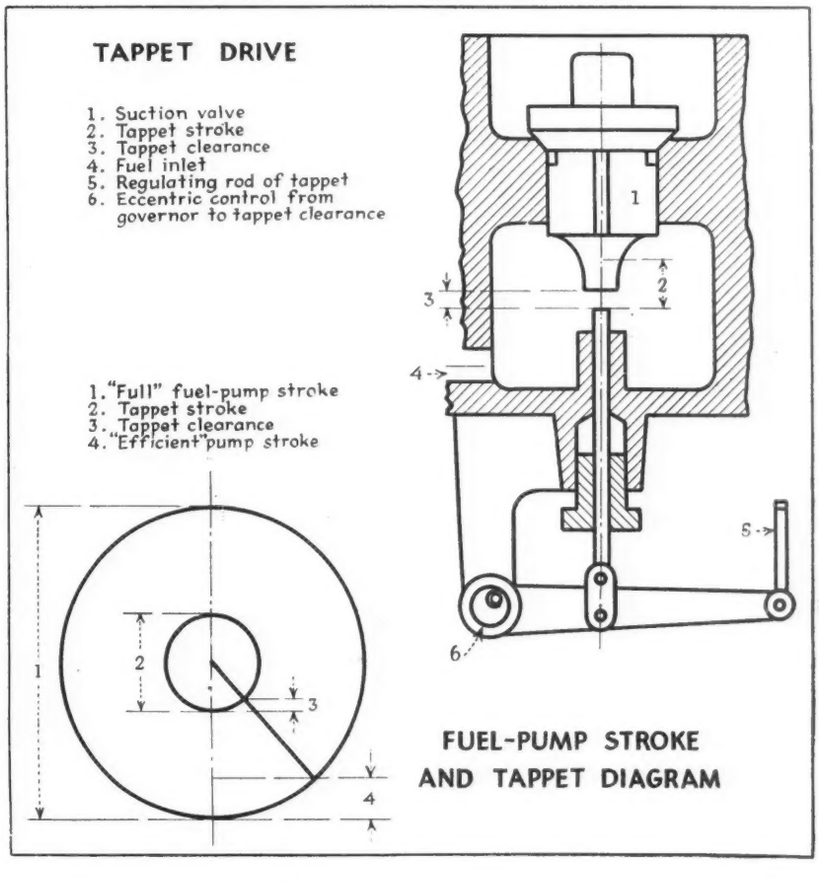
$$\frac{550 \times 0.44 \times 3 \text{ in.}}{500 \times 1} = 1.45 \text{ in.}$$

and tappet clearance $= \frac{1.45 \times 0.75}{3}$

$= 0.362$ in.

For any other power, the same ratio holds good, so that tappet regulating gear and governing control gear must be designed on this basis.

Fig. 4—Arrangement for tappet drive to lift fuel-pump bypass valves, and stroke and tappet diagram



DIESEL ENGINEERS MEET

Oil & Gas Power Division, ASME, holds annual meeting at Penn State. New engines, sludge-gas engines, waste heat, lubricants and fuel oils included in program

By J. W. Anderson

THIS MEETING, Aug. 18-21, under the auspices of the Oil & Gas Power Division, ASME, at Pennsylvania State College, was the largest and most successful of its kind to date. Registration approached 300. Presentation of papers and discussion was divided into five technical sessions, each centering around some special phase. There was one general session, a fuel and lubrication session, and one each on transportation, operation and research.

A symposium of progress was presented in statements by several diesel manufacturers. The growing demand for engines of lighter weight per horsepower and less bulk than the established types has brought the Buechi system of supercharging 4-cycle engines into successful use in this country. Many manufacturers have brought out new engine designs of higher speed and less weight, making them more suitable for such work as portable power plants for oil-well drilling and for mobile equipment. These higher speeds have necessitated studies of combustion systems, and improvements have been made in the economy and general performance of these new designs. General Motors is extending its railway diesel into smaller sizes and plans to offer a multi-cylinder engine with cylinders 4¼x5 in., with a maximum rating of 30 b hp at 2,200 rpm for automotive, stationary and marine service.

Other new engines described were the Fairbanks Morse Model 42 2-cycle stationary, also their 8x10½ in., 4-cycle 720-rpm marine and stationary type, the De La Vergne Models VL, VO and VE, the Ingersoll Rand Type S, the National Supply vertical 2-cycle gas engine primarily intended for oil-field work, and the Nordberg diesel which burns natural gas for fuel, described in *Power* (September).

Navy Diesels

The Navy's Partieipation in Diesel Engine Development" was discussed by E. C. Magdeburger. While engines developed for Navy use have no direct application in commercial service, they do have an influence, and sizes and applications are interesting. Several purely experimental engines have been built by various engine manufacturers, and some are now undergoing service tests. They range in size from 40 to 85 hp per cyl and up to 950 hp per engine. They are designed to get a maximum of power from a minimum of weight and space. Engines for power boats range from 25 to 105 hp. Standby generator units run from 105 to 300 hp. And three engines are being built of about 700 hp per cyl with 3 cyl per unit, of three different designs looking toward development of engines suitable for auxiliaries.

The 1936 Oil-Engine Power Cost Report was presented. It continues the work carried on for a number of years, and this report contains data on 166 generating plants containing 458 engines totaling 246,666 hp.

Sludge-Gas Engines

The increasing importance of gas engines for generating power from sewage sludge gas was emphasized by W. B. Walraven. It was stated that approximately 0.8 cu ft of gas is available per person per day, but if all garbage were ground up and turned into the sewage system, nearly 2 cu ft of gas would be available. Some notable installations in this country include a 4,500-hp plant contracted for in New York, and the following plants now running: 1200 hp at Washington, D. C., 900 hp at Coney Island, N. Y., 825 hp at Peoria, Ill., 600 hp at Los Angeles, 360 hp at Topeka, Kansas, 335 hp at Springfield, Ill., 300 hp at Durham, N. C., and 300 hp at Cedar Rapids.

Gas production is maintained at as constant a rate as possible by properly heating the digestion tanks, and in some cases natural gas has been used to augment the supply and smooth out fluctuations in production of sludge gas. In general, sewage gas has the following percentages by volume: methane 65%, carbon dioxide 30%, hydrogen 2%, nitrogen 3%, and traces of oxygen, carbon monoxide and hydrogen sulphide.

Experience at Springfield indicates the importance of clearing the gas of moisture. Mixing valves on the engines seem always to be dirty, but there is no operating trouble from this. Compression ratios up to 6 to 1 are being used with entirely satisfactory results. Various spark timings have been tried and 23 deg before top center seems to produce best results. Various engine loads were tried, but when the brake MEP reached about 69 lb per sq in., the engine began to slip a little. Probably a rating of from 66 to 70 lb per sq in. is quite satisfactory. Only minor operating troubles have developed, mainly with spark plugs.

Waste heat from the engine is recovered, and final exhaust temperature is just above the dewpoint of water. A lower temperature corroded the boiler tubes. Engine efficiency is 22 to 26%; 37% of the heat in the gas is recovered in the water jackets: 16 to 20% from the exhaust: making a total of about 81% thermal efficiency. Lubricating-oil consumption of 2200 hp-hr per gal is obtained.

Waste-Heat Recovery

Waste-heat recovery was discussed at length by Glenn C. Boyer, of Burns & McDonnell. Starting with tables, charts and a discussion of the heat available from the different types of engines at various loadings, the problem of the utilization of this heat to the best advantage to suit the local conditions was taken up. Two general methods of using exhaust heat are available: using a waste-heat boiler, and not using one.

Two examples of the former method were given. In the first case, the exhaust silencer was enclosed and air was blown over it by a motor-driven fan and directed by louvers out into the engine room. The following formula, evolved from tests, is fairly representative of results this sort of system can be expected to give:

$$0.30\ H = 0.01659\ V\ (120 - t)$$

where H = total heat in Btu per min passing through the exhaust silencer

V = cu ft per min of heating air circulated around the silencer

t = inlet temperature of heating air

Usually the heating system will be satisfactory if about 5 cu ft of air are circulated around the silencer per rated engine horsepower. The formula assumes that the temperature of the hot air entering the room is 120 F and that the heat carried per cu ft of dry air at this temperature is 0.01659 Btu per deg F.

A power plant with three 650-hp diesels had a single fan supplying 4500 cu ft of air per min at a static pressure of 1 in. of water. This air was distributed over the three silencers, and the total cost of fan, ducts, brick enclosures for silencers, and adjustable louvers was about $750. The

building is 40 x 70 ft. In both systems, hot water can be obtained from a coil in the exhaust pipes.

Another method is to use jacket-water heat in radiators with adjustable louvers thermostatically controlled. When room temperature falls below 70 F, the thermostat directs hot air into the room. Otherwise air circulating through the radiator goes out of doors.

Waste-heat boilers were discussed at some length and a special chart given for determining the quantities of steam or hot water obtainable under various operating conditions. It was brought out, especially in the ensuing discussion, that when a single waste-heat boiler was used for more than one engine, there was the problem of providing a tight 3-way valve. Dry operation of such boilers was decried; rather use bypasses to regulate the amount of heat sent through the boiler. Corrosion is a problem, and final gas temperature must be kept above the dewpoint of water.

Lubrication

Lubrication problems were discussed by C. G. A. Rosen of Caterpillar and by H. A. Rugg of the Pennsylvania Grade Crude Oil Assn. The most important problems to be fought are sludge formation and piston-ring sticking. Caterpillar ran many tests under various load and design conditions with different lubricating oils. Formation of sludge deposits in ring grooves was studied, and while the lubricating oil used has an important influence, this is not the whole story. Dust particles must be removed from intake air to avoid accumulations around inlet-valve stems and rings. The lubricating oil itself must be resistant to sludge formation under the existing heat conditions, and what sludge is formed must be removed as promptly and completely as possible. Breaking-in of the engine has an important influence on wearing qualities of the cylinder-liner surfaces long after breaking-in is over. Caterpillar found that compounded oils (lubricating oils with additives) gave improved results.

The Pennsylvania Grade Crude Oil Assn. does not believe in additives. While they do accomplish results, the feeling is that they also bring undesirable complications, and sometimes it is necessary to add another additive to overcome the difficulties of the first. Rather they prefer to work with a straight lubricating oil.

Fuel Oils

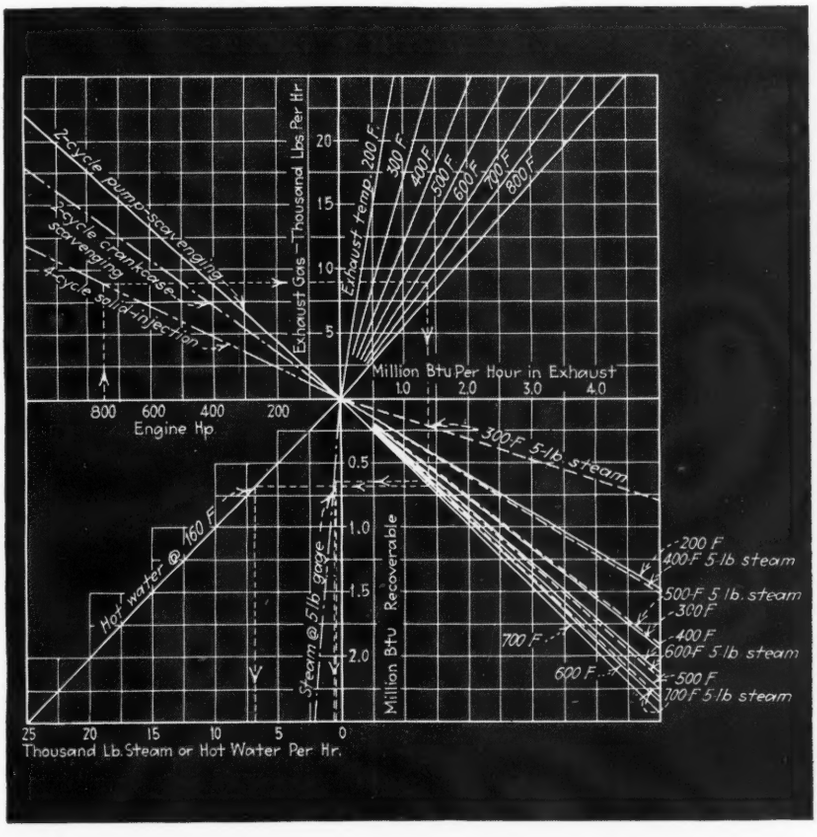
There were several papers on fuel oils. Two by members of the Penn State College staff described the Penn State method of fuel testing and a method of determination of the rate of jerk-pump fuel-injection-system discharge. Methods previously developed for determining the rate of fuel discharge from an injection system have been very complicated, and in his paper at this meeting Prof. DeJuhasz presented a simplified graphical conception of solving the problem.

The results of a large number of tests made at the Naval Engineering Experiment Station to correlate laboratory tests on diesel fuels with service engine operation were reported by W. F. Joachim. 25 undoped fuels having a wide range of ignition qualities and other physical-chemical characteristics were analyzed in the chemical laboratory, tested in the CFR engine for critical-compression ratio and for cetane number, and in a small 4-cycle Fairbanks Morse engine for engine operating characteristics. 13 ignition-quality indices were plotted against engine performance.

In addition, 83 fuels consisting of 35 undoped and 24 doped fuels, 6 miscellaneous, 7 secondary-reference and 7 cetane or primary-reference fuels were analyzed and tested in the CFR engine and in a Winton 75-hp, 750-rpm, open-combustion-chamber engine. Again results were plotted. Results of these tests on both doped and undoped fuels showed that only the knockmeter-delay cetane number on the CFR engine and the ignition-delay cetane number from the Winton engine correlated with the service-engine fuel performance, and that only an engine test based on ignition delay or combustion shock measurements could be relied upon to predict service engine performance. Among other things, the tests showed clearly that while the fuel characteristics have an effect on engine performance, their influence varies according to the engine design and the form of the combustion chamber.

A study of diesel fuels was presented by W. H. Hubner and Gustav Egloff of Universal Oil Products. Sources and production of fuels with their natural characteristics were compared with the specified characteristics given by engine builders, some users, and the ASTM specifications. There are several methods available of obtaining the desired results. It was pointed out that each refiner will use the method best suited to meet his individual economic problems. Straight-run products will be added in sufficient quantity to produce the proper ignition-quality characteristics. The amount of each will depend upon the cetane ratings of both the straight run and the cracked materials. There was a discussion of the method of evaluating diesel fuels, and it was stated that a better correlation between engine ratings and calculated ignition quality expressions may be obtained by the proper combination of physical properties.

Chart for determining economical heat recovery from diesel exhaust (Boyer paper. Enter at "Engine hp," at left, and follow around, turning at proper index lines)



Delegates to 55th NAPE Convention assemble in the grand ballroom of the Jefferson Hotel, St. Louis, Mo.

Power Engineers Convene in St. Louis

ATTENDED BY 3,146 delegates and guests, the National Association of Power Engineers held its 55th annual convention at Jefferson Hotel, St. Louis, Aug. 30 to Sept. 3. Grand Rapids, Mich., was selected as the 1938 convention city. The following officers were elected or continued for 1937-38:

President, Charles Bindrich, Milwaukee; Past President, H. W. Wilds, New York; Vice-President, Fred C. Laufketter, St. Louis; Secretary, Fred W. Raven, Chicago; Treasurer, E. J. Burke, Philadelphia; Trustees, Thos. Gambute, Detroit, Con Nelson, Minneapolis, T. R. Herlihy, Los Angeles, A. P. Thompson, Kansas City, W. W. Downey, New York; Doorkeeper, Donald L. Kurtz, Newark, N. J.; Conductor, L. V. Wilson, Phoenix, Ariz.; Board of Arbitration, Jos. F. Carney, New York, J. A. Prudell, Milwaukee, and W. J. Reynolds, Hoboken, N. J.

Fred C. Laufketter, general chairman, presided at the official opening Aug. 31, which included addresses by St. Louis Smoke Commissioner Tucker, National President Wilds, National Vice-President Bindrich, National Secretary Raven, and Director Hay of the St. Louis Chamber of Commerce.

Among subjects discussed in subsequent business sections was the license-law situation. It appeared that progress is being made in many states toward effective laws for operating licenses, also that most earlier controversies with professional engineering groups are being ironed out to the satisfaction of all concerned.

Associated Events

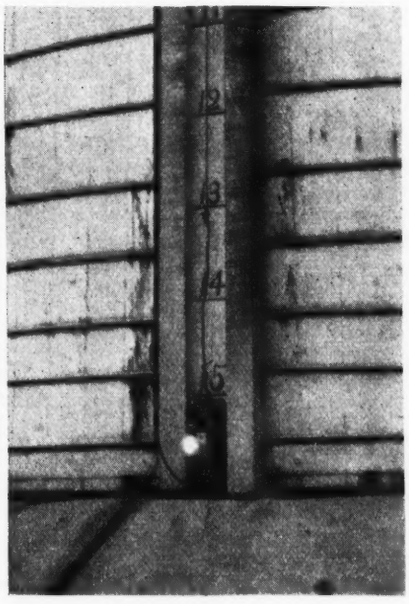
The convention program included one technical paper, "The Evolution of a Chain-grate Furnace" by R. Frank Hollis of Missouri No. 2.

Associated events included: visit to Anheuser-Busch Brewery, national officers' reception, exhibitors' entertainment and vaudeville show, state dinners and caucus night, steamboat ride on the Mississippi, public installation of national officers. The ladies' auxiliary had its own elaborate program.

Nearly 500 delegates and guests visited the huge Anheuser-Busch Brewery, enticed in part by the free beer and in part by the opportunity to inspect the large power and refrigerating plants and the extensive manufacturing operations. Anheuser-Busch can turn out 1,000,000 bottles of beer in 8 hours, covers 75 city blocks, employs 6,000 men. Power peak is 8500 kw, steam 270,000 lb per hr. Refrigerating capacity totals 3340 tons. Steam is generated at 500 lb. Process steam is bled at 140 lb, 40 lb and 5 lb.

Closely associated with the convention was the 36th Annual Power Show of the N.A.P.E. 74 exhibitors occupied 100 booths on the mezzanine floor of the Jefferson Hotel and presented an excellent display of power equipment, supplies and accessories. Such specialties as valves and fittings, traps, heating, air conditioning, oils, refractories and wire rope were well represented.

PRACTICAL AIDS TO OPERATION



Lamp Installed on Tank-Gage Target

IN PLANTS operating on a 24-hour basis, exact knowledge of water-tank contents is as vital at night as at day. One plant, needing a liberal supply of cold water at all times, made it easy for the man in charge to determine the water on hand by installing a lamp in a waterproof socket on the tank-gage target. This lamp was connected to the plant lighting system with flexible conductor long enough to permit the target to make full travel up and down the tank.

The bright ball of light from a 100-watt bulb shows up against the dark bulk of the tank, and makes it easy to determine how much water is available. So effective was the first installation that the company has equipped all tanks with these indicators.

New Orleans, La. R W BOWLES

Causes of Low Capacity in Centrifugal Pumps

OCCASIONALLY a centrifugal pump will deliver rated capacity for months and then fail. This happened with a 3-in. pump supplying water to a sand washer against a head of approximately 60 ft. Water was taken from a small pond, through a suction pipe carried out on posts to a considerable depth. A foot valve on the end of the pipe was protected with a screen against entrance of solids.

After inspecting the piping for leaks, the pump was taken apart and three small stones found wedged in impeller openings. Inspection of the intake showed that the screen had rusted out, leaving an opening large enough for the stones to pass through. Replacing the screen and raising the suction clear of the bottom made a free inlet and returned capacity of the pump to normal.

It is not uncommon to find the suction nearly buried in pumping from an excavation. Capacity of a pump operating under these conditions gradually grows less as the pump casing and runner wear. Some pumps used for handling sand and gravel or other solids are constructed with renewable liners. While in most cases it would be noticed immediately, loss of pump capacity has in a few instances been caused by a hole worn directly through the casing. A decrease in speed will also cause a loss in capacity. With a direct-drive pump coupled to an induction motor this is not very likely to happen, but when a gas engine is used, a reduction in speed can easily occur. And when a pump is driven by a belt, there is always possibility of slippage.

Sayreville, N. J. H B HUMPHREY

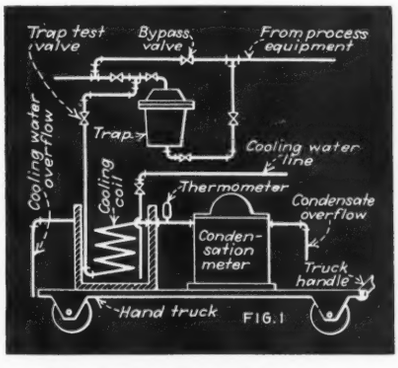


FIG. 1

Steam Consumption of Process Equipment

ENGINEERS in industrial plants are continually asking themselves or being asked how much steam a particular unit of equipment uses. While the principal reason for this questioning is, or should be, economy in steam utilization, other things often come up, among which are: Is a trap large enough for a given job or should its orifice be changed? Is dirty heat-transfer surface responsible for low production or has something gone wrong with the process? Why do peak demands coincide and can they be eliminated?

In a large chemical plant this information is obtained by using a portable condensation meter and a portable flowmeter. As all traps are equipped with test valves, the condensation meter and cooling coil, Fig. 1, are used wherever total consumption or trap capacity is determined. The flowmeter, Fig. 2, is installed when more comprehenive information is needed.

All steam lines to major steam-using equipment are provided with removable sections of pipe of a given length. The flowmeter orifice is installed in a portable section of the

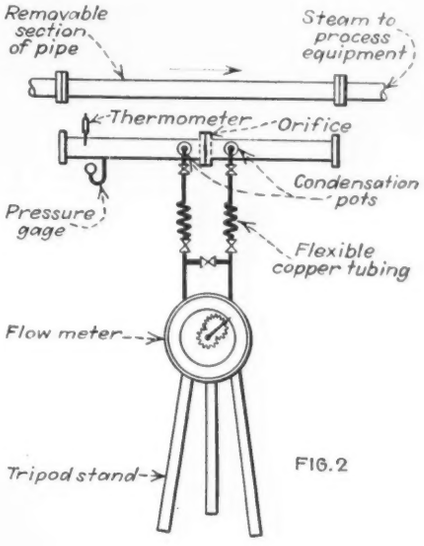


FIG. 2

same length and can be substituted with a minimum of effort. As the metering section has a diameter as large as that of the largest diameter line feeding any piece of equipment, reducing flanges are used on smaller diameter lines. To secure reasonable accuracy at different ranges, a meter having tubes of changeable range is used.

Roanoke, Va. S H COLEMAN

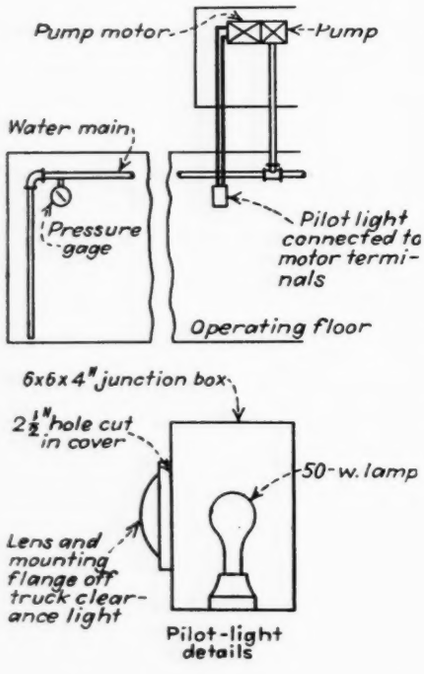
Fouled Baffle Causes Low Steam Pressure

IN OUR power plant we have two marine-type boilers that operated satisfactorily for several years, at ratings up to 175% of normal. Recently we began to have low steam pressure at the engines, even though pressure at the boilers was apparently correct. We examined the stop and non-return valves and found them open and in good condition.

Attention was then given to the in-

side of the steam drum. Here a baffle plate was found, originally intended to help stabilize water in the drum, as the boiler was built for service on boats. Holes, for steam flow through the baffle, were found practically closed with scale. When the baffle was cleaned, steam pressure at the engines again became normal.

York, Pa. WILLIAM MADEE



Water-Supply Safeguarded by Pilot Light and Gage

TO INSURE an uninterrupted supply of water to an important plant, the simple scheme shown in the figure was used. A pressure gage was put on the operating floor, and connected to the water main. A pilot light was connected to the pump-motor terminals, several hundred feet away. The light could, of course, have been mounted near the gage, but in this case was plainly visible from the operating floor.

The two devices were used, because at times a large amount of water is drawn from the line and normal pressure reduced. After a few minutes the pump should start, which would be shown by the signal light.

Radford, Va. G R ELDER, JR.

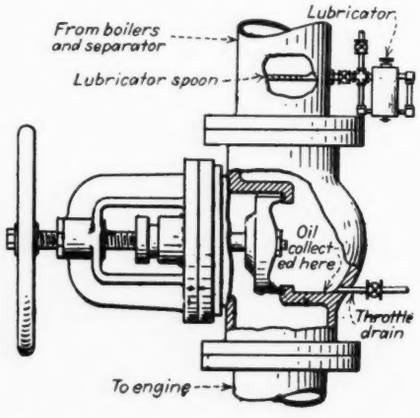
Tracing a Source of Oil in Boilerwater

OIL is the most dangerous foreign matter that may get into a steam boiler. Even slight oil deposits cause burned and bulged tubes and shell plates, and failure of these parts. The more common sources of oil, exhaust steam from reciprocating equipment, are quite well known and guarded against. In spite of all precautions, every now and then oil gets into the feedwater system.

One cause of oil in boilers was traced recently, and checked before serious damage occurred. Five water-tube boilers had operated for many years without a trace of oil in them. Exhaust steam from the engines passed through a filter and condensate from process was put through an open feedwater heater and coke bed. All filter equipment was of excellent design and properly maintained.

About a year ago, slight traces of oil were found in the boilers. This was cleaned out and a check on all filters failed to show the source. Six months later more noticeable deposits of fresh oil were found.

A method of tracking down the source was followed that can be recommended for many other plant difficulties. A log book in which all operating and maintenance items were recorded was kept in this plant. The probable time that troubles from oil deposits started was fixed at about January, 1936. The log book was



then examined for every entry between November 1935, and March, 1936. An item was discovered describing a change in drip piping made on Dec. 15, 1935. The valved throttle drains from three engines had been changed so that instead of discharging into the hot well, they went to drip receiver behind the boilers. This receiver takes care of all live steam drips, and no exhaust from any source entered it. A return pumping trap fed this condensate to the boilers. As the throttle drains were assumed to be pure condensate, it was considered unnecessary to pass them through the filter.

Investigation of this drip line showed that cylinder oil from the lubricator spoon dripped into the lowest part of the throttle valve, as indicated in the figure. Here, a small pool of oil collected with the condensate and every time an idle engine was warmed up for starting, the oil was blown out with the condensate and back to the boilers. Drips from the throttles were repiped to pass through the filters and no further oil deposits have been found in the boilers.

Chicago, Ill. C A ARMSTRONG

Isolating Underground Cable Failures

IN UNDERGROUND wiring systems, there are usually many lead-covered cables near or in contact with each other where they pass through connection vaults or manholes. Heat produced by failure of one cable often causes loss of several more.

This is guarded against in many plants by application of an asbestos covering over each lead cable extending from the point where the cable enters the vault to its exit. Special insulation for this work is a thick asbestos tape which is half-lapped around the cable, similar to taping up an electrical splice. Over this tape is applied a special heat-resisting cement, which gives a hard waterproof finish. This so isolates the individual cables that failure of one does not damage the others.

Waynesboro, Va. J M MEYERS

How Big the Reducing Valve?

IN MOST factories using steam for heating or process work, reducing valves are standard equipment. Too often, however, they are purchased without proper consideration on correct size or suitability for the service. It should always be kept in mind that a reducing valve reduces pressure by throttling, that is, by resistance offered by a restricted orifice. Therefore, even when carrying full load, the valve-opening area must be less than that of the pipe.

To purchase a reducing valve of the same nominal size as the pipe, in which it is to be installed, is a common error. When this is done, the valve seldom if ever fully opens, and at light loads it operates with the disk just lifted off the seat, which causes wire drawing, poor regulation, and scoring of disks and seats. It is not often necessary to install a valve of more than half the high-pressure pipe diameter. Some reducing-valve manufacturers publish reliable operating data based upon actual tests and others provide capacity lists apparently based upon one of the orifice formulas. In some cases, it does not appear possible to get any information other than that contained in lists

which are presumed to apply to all reducing valves and which probably do not rightfully apply to any.

If reliable information can be obtained on the equivalent orifice area of the valve at full opening, we can get a rough idea of its maximum capacity, by applying Napier's formula $W = AP \div 70$, where A is the orifice area in sq in.; P, high pressure in lb per sq in., and W, weight of steam flowing when the pressure on the discharge side is approximately less than 0.6 of P.

A reason why this method is approximate is that a reducing valve does not provide a simple metering orifice. Tests have shown that in many valves the greatest steam flow occurs when the pressure differential is 0.5 or more of the initial pressure, instead of only about 0.4. Of course, differences in design make it impossible to accurately estimate the performance of one make of valve by using data applicable to another.

When reducing valves are required for heating or similar service, where the pressure has to be reduced from high boiler pressure to a few pounds, valves specially designed for this class of service should be purchased. It is well to remember that after passing through the reducing valve, the low-pressure steam is superheated, which may possibly account for the erratic behavior of some heating systems, and the tendency for some thermostatic traps not designed for high temperatures to engage in a sit-down strike.

Bloomfield, N. J. J O G GIBBONS

Ease of Operation Makes for Safety

BECAUSE familiarity breeds contempt, it may often lead to disaster as well. A case in point is in the operation of valves and fittings on pressure lines. Something goes wrong with a valve and it sticks. The engineer goes for his hammer, gives the valve a couple of light taps, and the valve returns to normal operation. Thus a very bad habit is born. One may do this many times with the same desirable result. Then, one sad day, the fitting breaks under the combined strain of internal pressure and the blow, and the attendant is badly scalded.

When a valve operates with difficulty, this is plain evidence that it should be overhauled or replaced. If replaced, possibly a different type of valve should be used, one better adapted for the particular class of service. Replacement, or overhauling so that it again will operate with freedom, removes the ever-present temptation to grab a hammer. Hammer operation is a sure and certain sign of potential danger, and it is one of the earmarks of an inefficient engineer. It is not a thing to be avoided as much as possible, but altogether, so far as it applies to steam lines under pressure.

Peoria, Ill. JOHN E HYLER

Speeding Up Reseating of Pump Valves

COOLING water for a battery of internal-combustion-engines in one plant carried alkali enough to rust tight any junction of metals exposed to its action. Operators got along with leaking valves for periods long past the time when good operation demanded an overhaul, just because of the difficulty involved in the job.

A new chief engineer decided to try for better valve seating and consequent lengthening of overhaul intervals. He took an electric drill, rigged

a mandrel carrying a grinding head, and put two 0.5-in. bolts through the upper half of this grinding head, with threaded holes for them to screw into in the lower portion. This head, composed of two discarded follower heads for the pistons of the pump, made a loose fit on the hexagonal shaft of the mandrel. A pair of discarded valve springs were slipped over the mandrel and compressed between motor and grinding head to provide a flexible mounting for the head, so that any misalignment of the motor shaft would not affect the grinding-head rotation on the valve seat.

No. 0 emery cloth, cut in a disk to fit the grinding head, was used. Four tabs were left on the disks, folded up over the lower half of the grinding head, and inserted between it and the upper section. Sections were clamped fast by tightening down the two 0.5-in. bolts.

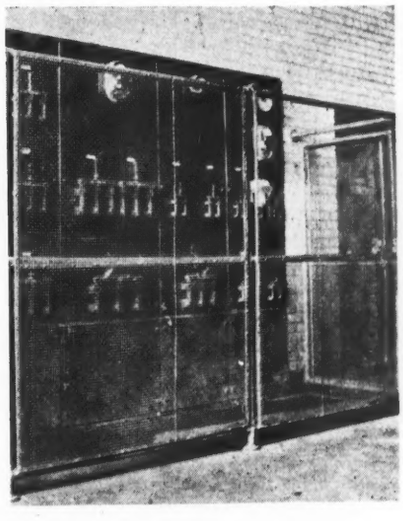
With this rig, the most stubbornly resisting seat could be faced in from 4 to 5 minutes. So effective was the grinder on valves within the cooling-water pump that it was also used on the discharge-valve deck. Seats ground in this manner required only light touching up with the valve and fine grinding compound to be tight. The grinding head, equipped with a pilot extension to fit into the center hole of the valve seat, kept the grinding disk from wandering out of place when it was being used.

Longview, Texas ELTON STERRETT

Protecting Small Switchboards

SMALL open-front switchboards are a potential accident hazard, especially when no operator is in regular attendance and danger of tampering by unauthorized persons exists. A simple method of protecting these panels with a wire screen enclosure is shown in the figure.

An enclosure of this type must be placed a sufficient distance away from the board so that there is no danger of an operator becoming grounded when throwing switches. A high-vol-



tage rubber mat on the floor should be used to prevent grounding of the attendant.

On this installation, the gate to the enclosure is kept locked and keys given to authorized persons. The lock is breakable so that quick access may be obtained in case of emergency or if keys are not readily available at the time.

Lynchburg, Va. O M ROBERTS

CURRENT COMMENT

Why HRT Boiler Braces Bow

IN MAY *Power*, Harry M. Spring makes a valuable contribution in answer to a vexing question. From my own experience, I am not so sure that permanent elongation of the braces is the entire reason for their bowing. In a case in mind, overheating of the lower shell plate, while not serious, was the primary cause. This caused a bending of the front tube sheet just below the point where the stays go through it. A permanent set seemed to take place at this point, because when the boiler was open, a straight edge laid on the tube sheet next to the braces showed that the surface was not flat.

While braces were of sufficient strength in tension, they did not offer the same resistance to compression, and allowed the tube sheet to bend inward starting at a point just below the lower tube row. This inward bending of the tube sheet caused the braces to bow up and also caused leaking at the lower tube ends.

Dorchester, Mass. W F O'REGAN

Additional Errors on "What's Wrong"

ERRORS in "What's Wrong With This Picture—XVII", page 526, September *Power*, can be supplemented by the following:

1. The opening in the brickwork where the blowoff piping passes through the rear wall should be packed with rope asbestos to allow for expansion.

2. The blowoff line beyond the blowoff valves should be increased in size as apparently another line comes in at this point.

3. The drain to the sewer should be made larger than the incoming line from the boiler.

4. The tank should be installed so that it will be accessible for external inspection.

5. Paragraph 14 says a 150-lb test tank should be used. It should be specified as "built to ASME standard for 150 lb safe working pressure".

Buffalo, N. Y. JOHN J TIMMONS

UNDER the article in September *Power* entitled "What's Wrong With This Picture—XVII", the following should also be listed:

1. Author states in a majority of cases steel fittings are used up to the blowoff valves. According to the ASME Code steel fittings are required.

2. Paragraph 4 of the article states "a globe valve or other positive-closure type should be used next to boiler." The Boiler Code states that "straight-run globe valves of the ordinary type . . . or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used. . . ." Two slow-opening valves, or one slow-opening valve and a cock, may be used.

3. The blowoff tank should have dished heads.

4. Vent piping should be larger than the piping entering the blowoff tank and should be piped to safety.

5. Author states a 150-lb test tank is used. I believe a stronger tank is necessary for safety, and to allow for deterioration.

Binghamton, N. Y.
CHARLES W CARTER, JR.

Further Comment on July's "What's Wrong"

THE ARTICLE "Additional Errors for What's Wrong—XV", page 524, July *Power*, calls for still further discussion, as it does not fully explain safe operating conditions.

Paragraph 6 states that the relief valve should be on the feed line. I believe that the relief valve should be on the tank heater. The feed line is small and subject to closing up due to foreign deposits which might render the valve inoperative. Also, if a mechanic should install the relief valve outside the stop valve, it could be closed and pressure would build up in the heater.

Why wouldn't it be good logic to install a check valve in the feed line to prevent pressure from the heater forcing water back into the feed line, thereby damaging a meter or causing injury to someone opening a cold-water line?

Binghamton, N. Y.
CHARLES W CARTER, JR.

Steam Engine or Turbine?

WHICH IS *considered better modern practice—steam engine or turbine—to operate under the following conditions? Prime mover to drive directly a 2,300-volt, 60-cycle, 3-phase generator. Steam to be supplied at 125 lb. gage and 99.7 per cent quality at the throttle. Back pressure 3 lb. gage. No superheater and no chance of obtaining any. Personnel is now operating steam engines with success, but totally unfamiliar with steam turbines. A 500-kw. unit is contemplated.*—L.F.L.

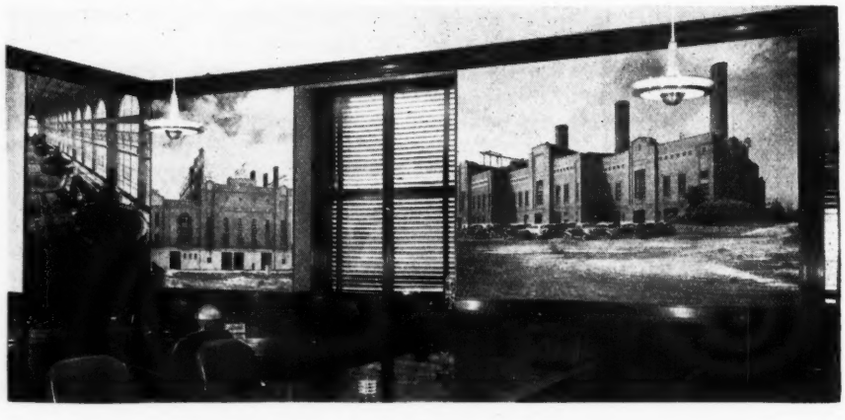
FOR the throttle and exhaust pressures you give, and the throttle condition of the steam, a theoretically perfect engine or turbine would consume 22 lb. of steam per kw.-hr. Assuming an over-all efficiency of a uniflow-engine generating set (including generator) to be 71 per cent, consumption would be 31 lb. per kw.-hr., and the moisture in the exhaust steam about 8 per cent.

Assuming 50 per cent as the corresponding efficiency of a turbine unit, its steam consumption would be 44 lb. per kw.-hr., and the moisture in exhaust about 5 per cent. Actual efficiency of the unit might vary considerably with its load and age. In addition, the efficiency of the turbine would show larger differences between a high-class and a cheap machine.

It would then appear that the turbine is the best choice *if*. The "if" is the matter you forget to mention. How is your exhaust steam used. If the higher steam consumption of the turbine means that you are going to blow a lot of exhaust steam out to the atmosphere, it will cost you a lot of added coal. If on the other hand you can absorb all the exhaust in heating and process, then every pound of exhaust steam saved by the lower consumption of the engine will save you from 0.1 lb. of coal to 0.12 lb. You can figure the actual saving if you know your actual power, process and heating steam loads and will study these in connection with actual steam consumptions as guaranteed by engine and turbine manufacturers. The figures used here are only estimates. You need to know the actual steam consumption of the machine you are considering at full, half and quarter load.

PHOTOMURALS

Inside the executive offices of the Public Service Co of Northern Illinois, showing some of the photomurals executed by Kaufman & Fabry Co, installed to depict the power company's service facilities. The murals were enlarged from camera pictures a few inches square



READERS' PROBLEMS

QUESTIONS for Our Readers

Babbitting a Bearing

Question 1

I WOULD *like to know how to babbitt a main bearing (8-in. in diameter) on a horizontal ammonia compressor. The bearing, of a four-part design, must be poured in place on the shaft. Because the crank-shaft hub is close to one side of the bearing pedestal and a collar is shrunk on the shaft on the other side, bearing sections cannot be taken out endwise. There is just enough clearance above the flywheel to permit raising the shaft sufficiently to roll out the bottom quarter of the bearing.*

I do not like to pour hot babbitt on one side of a cold shaft but I can find no way of heating the shaft uniformly, as it cannot be revolved while heating. Since the room temperature is around 100 F, preheating the shaft may not be necessary. Heating the shaft on one side might spring it.

I could pour the bottom quarter of the bearing first and then pour the side quarters, with the wedges in place. No shims or liners are used between side and bottom quarters. It seems to me that if cardboard or similar liners are used to keep the metal from running past the shaft when pouring the side quarters, equivalent metal shims will have to be placed permanently in the bearing. Should the top quarter of the bearing be poured in position or on a mandrel?—AGH

Soot Blowing

Question 2

A MANUFACTURING *plant used compressed air for blowing soot from several hrt boilers for a number of years and then switched to steam. We have heard that compressed air has an injurious effect on the tubes. Can any* POWER *readers give me some first-hand information on compressed air for soot blowing?*—EHR

Suitable answers from readers will be paid for if space is available for publication.

Gasoline or Diesel For Standby?

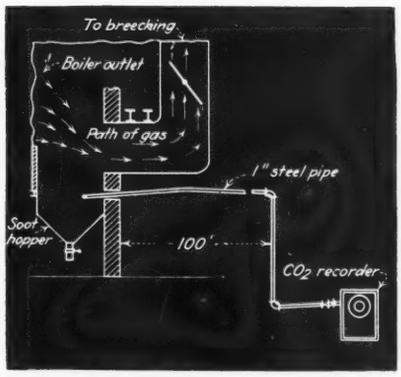
Answers to August Question 1

The Question

WHAT *with floods and occasional power failures, I have suggested to our management that some sort of emergency power source be provided, because certain of our processes must not be interrupted. I am working at the moment on a plant to provide 100 kw. Should this be gasoline or diesel? The gasoline engine I understand is much cheaper in first cost, though more expensive to operate; the diesel has possibilities for peak-load tie-in. Diesel operating costs are readily available, but do any readers have operating and cost statistics on gasoline engines in stationary service, showing something of costs at various loadings, assuming constant engine speed?*—AVK

WHAT'S WRONG WITH THIS PICTURE?—XX

CO_2 Recorder Piping



THERE are at least 11 errors shown in this drawing. Make a list of those you recognize, then compare with those on page 646

Diesel Starts Easier

THIS 100 kw. should be diesel, because it is more efficient to operate and cheaper to maintain. It will always provide power when necessary. When you shut a gasoline engine down, maybe you can start it up again when you need it and maybe you cannot. The diesel will start when you need it.

Muncie, Ind. JOHN L WHITE

Close Analysis Required

I WOULD suggest that AVK analyze his problem a little more in detail before installing either a diesel or gasoline plant of 100 kw. Either might show a paper profit if certain assumptions are made which would change after the plant was in operation. He should make sure that all labor costs are included and not just pass this item off with, "We'll have Joe, the night watchman, take care of the plant during an emergency at five bucks more per week." Joe might be laid up with rheumatism just at the critical period. Then too, unionism, another ism, is sweeping the country and might raise his estimated labor cost considerably.

The percentage allocated for maintenance shouldn't just be estimated for the period the plant is being paid for, but on the expected life of the standby plant, and a liberal charge for part replacement should also be included. Fuel prices vary too, so he should use a fairly high average price in his estimate, or be sorry afterward.

Then too there are always some extra items, such as relays, meters—mechanical gadgets which are later suggested as an aid in operation but which are seldom considered in the first estimate.

With regard to the type of plant to install, the gasoline plant and diesel plant will run approximately the same on maintenance cost and part replacement (labor) but the largest-cost item will be in the fuel.

My suggestion for a plant of only 100-kw capacity would be to use the present utility supply and arrange with the company to supply a separate power source to be used in case of emergency. This service could be obtained at a nominal additional charge and the company would exhaust all efforts to maintain service if the power-supply contract was properly negotiated. Continuity of service is one of the basic requirements of a utility service, and if power failures occur and no effort is made by the company to reduce the number and frequency of the outages to their customers then it is AVK's duty to report this situation to the Public Service Commission.

Tenafly, N. J. KERMIT B HOFFMAN

Use Generator for Power-Factor Correction

WE ADVISE strongly the use of a diesel rather than a gasoline engine. To begin with, there is not much difference in first cost, the only saving being in the cost of the prime movers—cost of all other equipment being the same. The over-all difference in cost would not be more than 10% in favor of the gasoline engine. Therefore, it can hardly be said that the gasoline-engine-driven unit is much cheaper.

The gasoline unit would be considerably more expensive to operate; i.e., roughly 50% more fuel consumption and, of course, gasoline itself is considerably higher in cost than fuel oil. The cost of operation of the gasoline unit would be at least double that of the diesel unit.

The fuel consumption for the gasoline unit falls off in about the same proportion as a diesel unit at lower loadings. At full, three-quarter, one-half and one-quarter load the diesel unit will produce approximately 12½, 12, 10½, and 6½ kwhr per gal. of fuel oil; whereas the gasoline unit would deliver 8½, 8, 7 and 4.4 kwhr per gal. respectively.

As AVK states, the diesel unit properly controlled offers attractive opportunities for peak-load tie-in. In either case, we suggest that the generator or generators be connected to their prime mover or movers through an automatic clutch. This will allow the generator to be used as a synchronous motor or synchronous condenser for power-factor cor-

rection. Furthermore, it will considerably simplify the automatic control; in fact, it eliminates the necessity of all automatic control as far as the electrical tie-in is concerned. The clutch used can be of the over-running, centrifugal, hydraulic, or ordinary friction-disk type; the latter, of course, arranged with automatic control to throw the clutch into service when the prime mover or movers are called for.

In the case of a peak-load tie-in, the unit could be arranged to cut in automatically when the load got up to a certain point. The alternator would then cease to be a synchronous condenser and become a synchronous generator. The amount of power input by the diesel unit can be accurately controlled by means of an exhaust-temperature controller on the diesel engine.

Boston, Mass. GEO B BAILEY,
Thermal Engineering Co

Consider Gas Engine

CONSIDERING the apparently limited amount of time that the emergency power source would have to function, AVK should give serious consideration to either gas or gasoline engines. These can be installed at a much lower cost per kilowatt of capacity or total cost than the diesel, and they have the particular advantage of fewer mechanical complications.

There have been developed a line of engines by the Waukesha Motor Company of Waukesha, Wis., for operating on gasoline as fuel and also on the liquified petroleum gases which are now easily available in cylinders. The ordinary gas used for such work is propane. This line of engines has been developed in small units for railway-car air conditioning and also for larger stationary installations.

Cedar Rapids, Ia. JOHN M. DRABELLE,
Iowa Elec Lt & Pwr Co

WHY FLAT BELTS WABBLE

Answers to August Question 2
The Question

WE HAVE *several flat belts in our plant that continually wabble across pulley faces. Some are leather and others of rubber construction, varying in width from ¼ to 12 in. They are apparently of liberal design and operate at moderate speeds of 2,500 to 3,700 ft per min. I am unable to locate the cause of the trouble and would appreciate learning about experiences of* POWER *readers in correcting this condition.*—RET

Align Shafting and Pulleys to Correct the Trouble

WABBLING belts are sometimes easily corrected by checking shaft and pulley alignment. Initially, an installation may be in good alignment, but settling foundations, expansion and contraction of woodwork, intermittent application of load, and machinery wear may cause misalignment.

This, in turn, causes belt slippage, resulting in power loss and early belt destruction. Pulley faces should be perfectly in line, and shafting parallel. Quite often, belt wabble is produced by improper splicing, which causes the belt to be crooked.

Clinton, S. C. HARRY E DOSTER

Pulsating Loads May Cause Trouble

BELT wabbling is usually caused by insufficient crown on the pulleys, by not properly squaring belt ends before joining, or by load too light for the width and speed of the belt. I have seen crooked belts wabble, and belts that wabbled under light loads run straight when loaded. If pulleys have sufficient crown and belts still wabble, a different pulley combination to reduce the belt's speed or a narrower belt may eliminate the wabble.

A reciprocating engine sometimes transmits pulsations that will make a belt wabble at light loads, but I do not remember seeing a belt wabble from this cause that did not settle down when reasonably loaded.

Coffeyville, Kan. EARL PAGETT

Belt Too Large for the Drive

SOME of our belts wabbled because they were too lightly loaded. This we remedied by using narrow belts. Because of peak loads on some drives, we had to use larger belts than necessary to drive the average loads. On these drives, the belts wabble only when the loads are light.

Fergus, Ont. H A CAMERON

Belt Slippage May Be a Cause

SLIPPAGE, the most probable cause of belt wabble, may be due to oil on the driven pulley. Frequently, where idlers are used on short drives, the trouble can be eliminated by increasing idler tension with weights or springs. Improper piston clearance or faulty valves in reciprocating units with belt drives will tend to cause jerking of the belt, and consequent slippage and wabbling. Grease or oil may be carried to the pulleys from idlers, main shaft bearings or crank case.

Osborn, O. J B LINKER

Necessary That Belt Be Straight

IN MOST cases, belt wabble can be traced to insufficient care in lining up the belt during lacing or cementing, or unequal stretch in different parts of the belt that pull it out of line. The latter I have never encountered in endless factory-fabricated belts. A straight-edge along one side of a belt will show whether or not the belt is straight. I always mark the ends and areas to be scarfed down with a square before cutting, and line up the belt with a straight-edge.

WHAT'S WRONG WITH THIS PICTURE?—XX

CO_2 *Recorder Piping—See page 645*

1. *Sampling pipe improperly located.* This pipe as shown is in a dead space. It should be placed near the boiler outlet where the greatest admixture of gases occurs and a more representative average sample is obtained.

2. *No filter on sampling pipe.* Without a porous earthen or Carborundum filter, the piping and recorder would soon choke up with flue dust.

3. *Sampling pipe enters setting sloping in wrong direction.* This pipe should slope downward in the direction of the recorder otherwise condensation would soon stop up the filter.

4. *No union on sampling tube at point of entrance to setting.* A union must be placed at this point so that sampling tube and filter may be removed for inspection and cleaning.

5. *No flange to prevent air leakage around sampling pipe.* Air leakage at this point and at any other point in the piping system will seriously interfere with recorder accuracy.

6. *The instrument line is trapped.* This piping should slope at least ½ in. in 1 ft, and some provision for drainage made at any point where the direction of slope changes. Drain bottles or drip legs with water seals are commonly used for this purpose.

7. *Steel piping used in instrument line.* Sulphur compounds in the gas soon cause corrosion where iron or steel is used. Brass or copper piping with sweated joints will give much better service.

8. *Pipe size too large.* Piping should not be larger than ½ in. A larger pipe has more storage capacity and increases the time interval between sampling and analyzing.

9. *Pipeline too large.* For the above reason the piping between boiler and analyzer should be short.

10. *No connection for test Orsat.* A connection should be provided as near as possible to the analyzer so that its accuracy may be periodically checked. A 3-way cock placed at the analyzer provides for both checking zero and a connection for the Orsat.

11. *No provision made for blowing out lines.* Plugged tees should be used in place of ells at all points where direction changes.

Waynesboro, Va. S H COLEMAN

Leather belting of poor quality will give trouble from unequal stretching. Replacement with good quality belting is usually a good investment. Sometimes the old belt can be cut narrower and used for light duty. Pulleys or shafting improperly aligned, or operation in a dusty or dirty location may cause a belt to wabble. Belts run best on pulleys that are properly crowned and slightly wider than the belt. If a belt has ample capacity for the load, but continually wabbles, the uneven edges can be cut off to make it run smoothly; otherwise, it will be necessary to rebuild the belt.

Chillicothe, Mo. LOUIS N WEAVER

Pulley Construction May Be Faulty

WE EXPERIENCED the same difficulty with belt drives and found that the principal cause was in the pulleys. RET should check to see if pulley sizes used for the belt and application meet recommendations for the best present-day practice. In our case, pulleys were sized correctly, but were out of alignment. We found some shafts running with excessive end play, which we now try to limit to 1/16 in. In a few cases, we found pulleys with different diameters at their outer edges or with crowns off center.

If RET finds pulleys and shafting in satisfactory condition, he then should investigate the contact sides of his belts for lumpy, hard surfaces, caused by application of dressings or sticky substances, joints in the belts carelessly or improperly made, belts overstretched or unevenly stretched when placed on pulleys, insufficient belt tension, belts overloaded, or belts needing dressing. We have found that a belt of good material and workmanship, properly installed and maintained, will not wabble providing the pulley equipment is of good design.

Tenafly, N. J. K B HOFFMAN

THE ENGINEER'S BOOKSHELF

Steam Boilers

STEAM BOILERS (2nd Edition)—*By Terrell Croft, revised by R B Purdy. Published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. 6x8 in., 417 pages, 450 illustrations. Price, $4.*

Terrell Croft's book on steam boilers has long needed revision, as the first edition was published in 1922. This second edition contains over 160 pages of new text and 144 new illustrations. Material has been added on steam driers, steam washers, waterwalls and superheaters. Text on stokers, pulverized coal, air preheaters, economizers, fans and feedwater treatment has been entirely rewritten and new illustrations included. The concise style of the first edition has been maintained.

Our Chemical World

MAN IN A CHEMICAL WORLD (1937)—*By A Cressy Morrison, published by Charles Scribner's Sons, 579 Fifth Ave., New York, N. Y. 290 pages, 6½ x 9. Price $3.*

This biography of the chemical industry, designed for popular reading, is an interesting account of this industry's career and influence on mankind. There is no information in the book that will enable an engineer to get more lb of steam per hr out of his boilers, yet every man knows that his world today is a technical one and that much of it is influenced by chemists and the chemical industry. This, then, is the story of that influence, its scope, growth, and activity.

Oil Burners

OIL BURNERS (1937)—*By Kalman Steiner. Published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. 436 pages, 6x9 in., 213 illustrations, 66 tables. Price $4.50.*

Starting with a thorough review of the chemical properties of fuel oils and the theory of their combustion, the author has brought together many tables of factual data on both theory and practice of oil burning. Not a handbook or service manual, the book deals exhaustively with up-to-date equipment and is profusely illustrated with both photographs and diagrams so that the reader obtains a clear understanding of the types of equipment available as well as the theory of their operation. A brief discussion of the combustion of solid and gaseous fuels aids in understanding the problems peculiar to oil burning.

Domestic, commercial and industrial burners are separately treated with discussion of their individual problems and applications. Additional chapters cover auxiliary equipment such as fans, motors and ignition. Service and maintenance problems are also analyzed in some detail.

This book is a readable collection of information and data on the rather wide field of oil burning and is a valuable reference text.

Chemical Handbook

HANDBOOK OF CHEMISTRY (2nd Edition)—*Compiled and edited by Dr Norbert A Lange, assisted by Gordon M Forker, and with mathematical tables and formulas by Dr Richard S Burington. Published by Handbook Publishers, Inc, Sandusky, Ohio. 1,800 pages 5⅜ x 7¾ in. Price $6.*

This reference book, while designed primarily for engineers and chemists in the industrial field, should prove valuable to the power engineer as a source of miscellaneous chemical and physical information frequently needed, but hard to find.

High spots from the power engineer's point of view are the more than 400 pages of tables of physical constants of organic and inorganic compounds, a table of the composition and physical properties of alloys, (particularly corrosion- and heat-resistant alloys), data on materials of construction, and tables of specific heats and heats of combustion for a long list of substances both common and uncommon.

Intelligent typography and generous page size make the tabular material, which comprises the bulk of the book, easy to read and attractive in appearance.

AC Machinery

THEORY OF ALTERNATING-CURRENT MACHINERY (1937)—*By Alexander S Langsdorf, Dean of the Schools of Engineering and Architecture, Washington University. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 788 pages, 6 x 9 in., illustrated. Price $6.*

In this college textbook, the author presents material and methods which are the result of 20 years of experience in teaching alternating current. An effort has been made to dispel the notion, quite common in former years, that there is a sharp distinction between dc and ac phenomena. To forestall some of the difficulties which commonly beset the student, all theory and explanation start from familiar and basic principles, and procede to a conclusion in an orderly step-by-step manner.

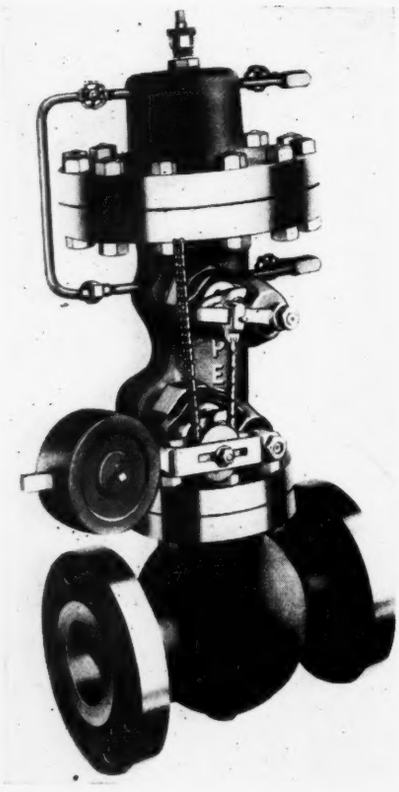
With the exception of electronic-type rectifiers, the book covers practically the whole field of ac machinery, including single-phase and polyphase circuits; transformers; synchronous generators, motors and converters; polyphase, single-phase and commutator-type motors; induction generators, phase and frequency converters. Though the book is largely theoretical, there is concrete information of value to the electrical engineer.

BRIEF REVIEWS

AKON FEEDWATER TREATMENT. *Bulletin 1542* (1937). *Published by Allis-Chalmers Mfg Co, Milwaukee, Wis. 16 pages. Distribution on Request*—Fundamentals of feedwater treatment presented in simple terms with particular reference to use of Akon as part of treatment for scale prevention, elimination of carryover and prevention of corrosion. Discussion of silica scale deposits and effect of copper corrosion summarizes latest knowledge.

SPEED-CONTROL HANDBOOK. *Published by Reeves Pulley Co, Columbus, Ind. 120-page booklet, 5½ x 7½. Revised edition, distribution on request*—Complete information on Reeves equipment, history of variable-speed control and transmission.

WHAT'S NEW IN PLANT EQUIPMENT



BOILER-FEEDWATER REGULATING VALVE

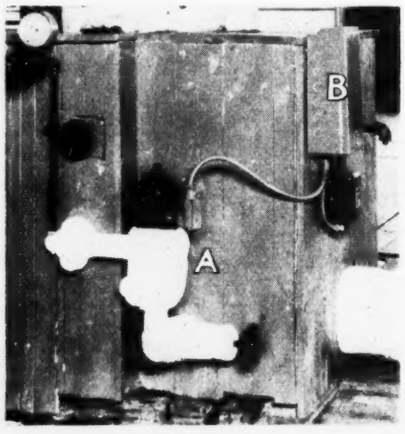
2-ELEMENT steamflow feedwater regulator feeds boiler according to rate of steam flow and provides water-level characteristics for best operating results on individual unit. A higher water level can be provided for heavy loads than on light, or practically constant level can be maintained for all ratings. Two control elements: (1) steamflow controller measures steamflow rate by taking pressure drop through superheater; (2) water-level thermostat, with tension expansion tube, responds instantly to changes in boiler-water level. Both are connected mechanically to feedwater-control valve so that valve is positioned by resultant of two forces. Either directly or hydraulically operated; may be installed on any position in boiler-feed line; made for pressures of 250 lb and up. Sizes of 2 to 6 in.

Northern Equipment Co, Erie, Pa.

LIQUID-LEVEL CONTROL

FLOAT chamber *A* consists of cast-iron chamber in which ball float rises and falls according to liquid level changes. On top of float is a rod which moves in and out of tube fastened to top of float chamber. Tube and chamber are subjected to internal pressure as situation may call for. Around outside of tube at its top is coil whose leads run to control box *B*. Rod moving in and out of coil changes electrical characteristics, causing relays to function in control box, thus actuating solenoid and motorized valves, motor-driven pumps or other connected equipment.

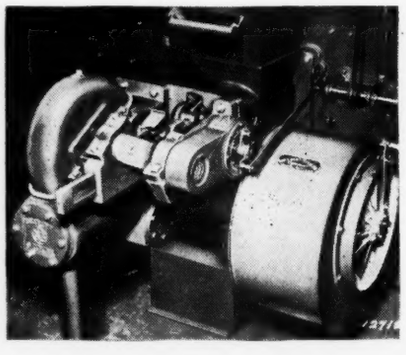
J G Russell Co, Inc, 103 Boston St, Boston, Mass.



MODIFIED SCHERING BRIDGE

FOR DETERMINING characteristics of liquid and solid dielectrics, modified Schering bridge applies high voltage only to test sample and to standard air capacitor. All adjustable elements are confined within grounded shield. Bridge intended for 60-cycle currents and air capacitor and sample holder rated 10 kv. Apparatus for other voltages and frequencies can be supplied. Catalog E-54(2).

Leeds & Northrup Co, 4934 Stenton Ave., Philadelphia, Pa.



ADJUSTABLE FEED FOR STOKERS

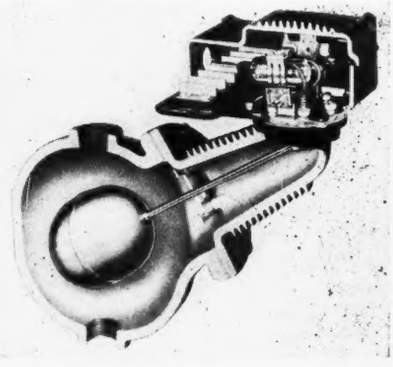
MAY BE applied to new or existing Detroit single-retort stokers and "Uni-Stokers" to provide a large number of positive rates of feed coal to stoker retort. Unit is built into right-hand crankshaft bracket of stoker; is either manually or automatically controlled. Master regulator of adjustable feed may be connected to damper at fan inlet to synchronize air supply with fuel feed, or may be connected to boiler uptake damper.

Detroit Stoker Co, General Motors Bldg, Detroit, Mich.

BOILER-WATER CONTROL UNIT

COMBINATION high-pressure-pump control and low-water cutoff starts and stops boiler-feed pumps according to boiler-water level. Two controls have separate operating levels, and differential between two circuits is adjustable. Flexible metallic bellows transmits float power to outside switch mechanism. If pump should stop and water level drop abnormally, cutoff stops stoker or oil burner and closes alarm circuit. For steam pressures up to 150 lb.

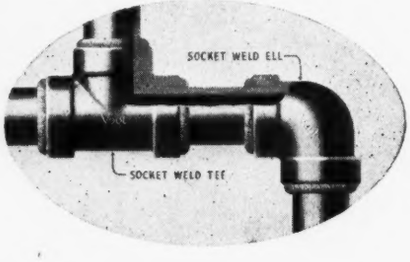
McDonnell & Miller, Wrigley Bldg, Chicago, Ill.



DROP-FORGED WELD FITTINGS

STEEL weld fittings have socket ends to receive pipe which insures alignment before and after welding. Socket construction said to keep weld "icicles" from forming in pipe or fitting. Whether standard, extra strong or double extra strong pipe is used, smooth passage through pipe and fittings is assured since fittings are bored to match inside pipe diameter. Manufactured in full range of sizes.

Henry Vogt Machine Co, 10th and Ormsby Sts, Louisville, Ky.



GAS INDICATORS

UCC GAS indicators detect explosive or irrespirable gas-air mixtures. Model 12-B, for detection of combustible gas or vapor, has graduated meter scale which indicates by direct reading whether combustible gas is present and whether concentration is below, above or within

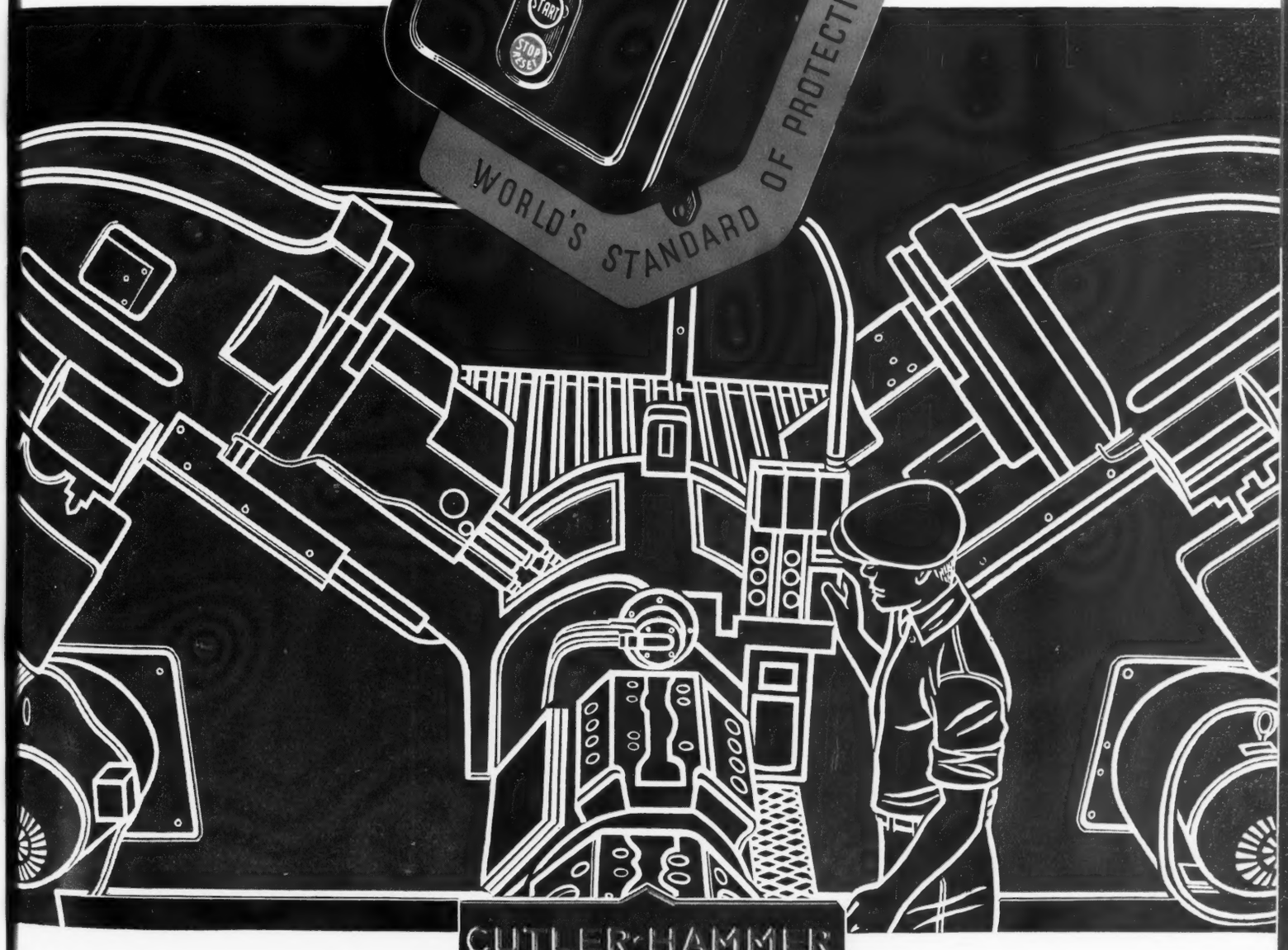
A SMALL MOTOR IS OFTEN
the Heart of a Huge Machine

● Most builders of motorized machines have long since learned that *size* is never an index of the importance of an electric motor or its control. This is indicated by the many machinery builders who feature "Cutler-Hammer Motor Control on *all* Motors." Machines so advertised are truly dependable because the failure of one of the smaller motors in a machine can cause as serious an interruption as failure of a large motor.

Thinking industrials recognize this in all their motor requirements. They insist on proven Motor Control for motors of *every* size. That is why Cutler-Hammer Bul. 9586 Motor Control is so widely preferred for the smaller motors of Industry. Its many features of superior construction, its legacy of the widest engineering experience and its unequalled record of performance *must* recommend it to you. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1358 St. Paul Ave., Milwaukee, Wis.

FOR SMALL MOTORS

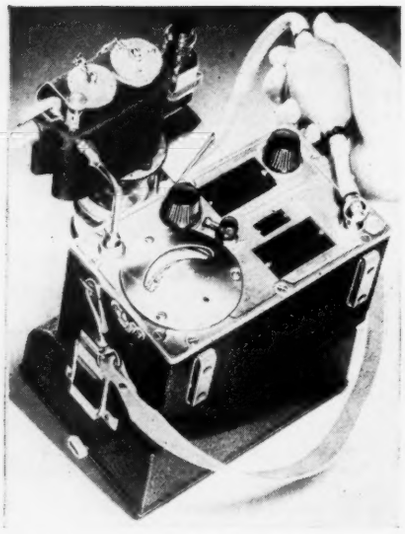
Built to a standard of millions of operations with heavy solid silver twin-break contacts and the famous C-H eutectic alloy overload relay. Featured as standard equipment by responsible machinery builders and stocked by reliable independent electrical wholesalers. Cat. 9586 AAA



JUDGE BY THE SIZE OF THE JOB

CUTLER-HAMMER
MOTOR CONTROL
C-H

NOT BY THE SIZE OF THE MOTOR

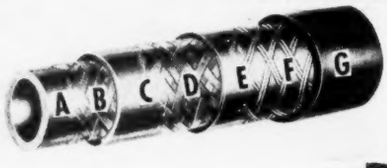


explosive limits. Model B-1 (shown in illustration) combines three units in one to show presence of combustible gas, to indicate oxygen deficiency, and includes toxic chamber for determining CO and H_2S. Both have patented air-dilution valve by which incoming samples can be diluted with any volumne of air, thus making it possible to detect flammable conditions which might not be indicated because of lack of oxygen.

Linde Air Products Co, 205 E 42nd St, New York, N. Y.

BURST-PROOF STEAM HOSE

TUBE *A and* insulting layers *C* and *E* of special heat-resisting rubber compound; reinforcement of high-tensile steel wire *B* and *D* which cannot burn out or deteriorate. Wire is applied in braided form with opening large enough



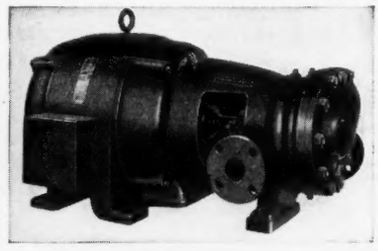
to permit rubber to rivet itself. Outside of wire braid and underneath cover is embedded additional braid of asbestos cord *F* to protect cover from burning. Heavy, long-wearing black rubber cover *G* compounded with special anti-oxidant (Agerite). Sizes $\frac{3}{8}$ to $2\frac{1}{2}$ in.

B F Goodrich Co, Akron, Ohio

2-STAGE MOTOR PUMP

BUILT-TOGETHER motor and pump, for heads up to 50 ft, consists of 2-stage centrifugal pump, with enclosed bronze impellers, mounted on shaft of Fairbanks Morse splash-proof motor. Two ball bearings take all of radial and unbalanced thrust loads. Impellers for 2 stages are back to back, compensating thrust. Improved hydraulic design attained by placing first-stage unit next to motor and second stage on outside, simplifying crossover passage and placing stuffing box under suction instead of pressure. Mounting leg under pump end gives added stability. Bulletin 5592.

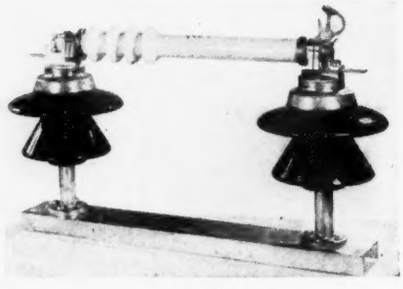
Fairbanks, Morse & Co, 900 S Wabash Ave, Chicago, Ill.



POWER FUSE

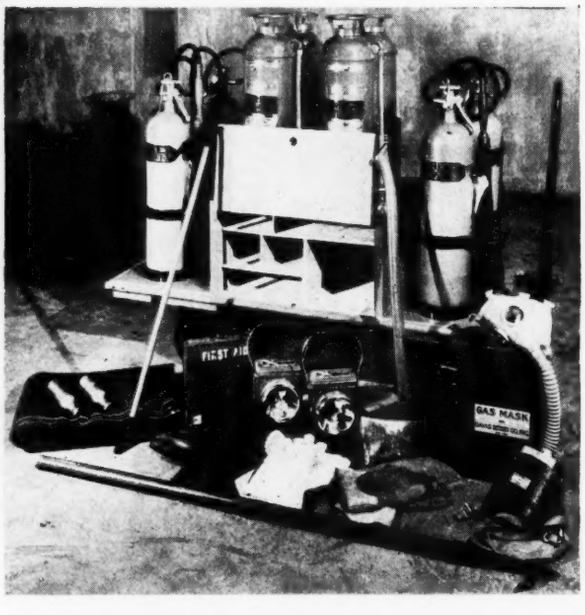
FOR SERVICE where short-circuit capacity does not exceed 600,000 3-phase kva, 34.5-kv, 200-amp disconnecting boric-acid "De-ion" power fuse is hinged at lower contact to open approximately 75 deg so it can be used as disconnect switch operated by standard hookstick. Refills packed with individual refilling tools. Operation of removing fuse from service, refilling, and restoring service can be accomplished in less than 1 min.

Westinghouse Electric & Mfg Co, E Pittsburgh, Pa.



FIRE-PROTECTION UNIT

PORTABLE unit has four 20-lb CO_2 and four pure-water extinguishers plus auxiliary equipment of an axe, two crowbars, rubber and asbestos gloves, blanket, first-aid kit, recharges for extinguishers, and gas mask. Unit may be handled by one person and is small enough to fit into elevators. Extinguishers in center are of new design in which pure water is expelled by pressure from CO_2 cartridge; four other extinguishers use dry CO_2 as extinguishing medium. Standard or special units can be supplied.

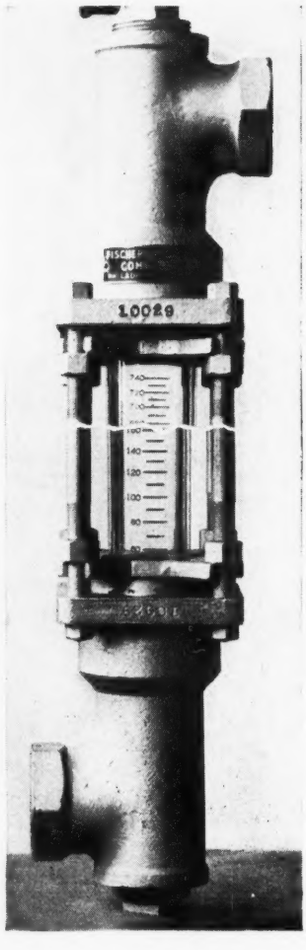


Walter Kidde & Co, 140 Cedar St, New York, N. Y.

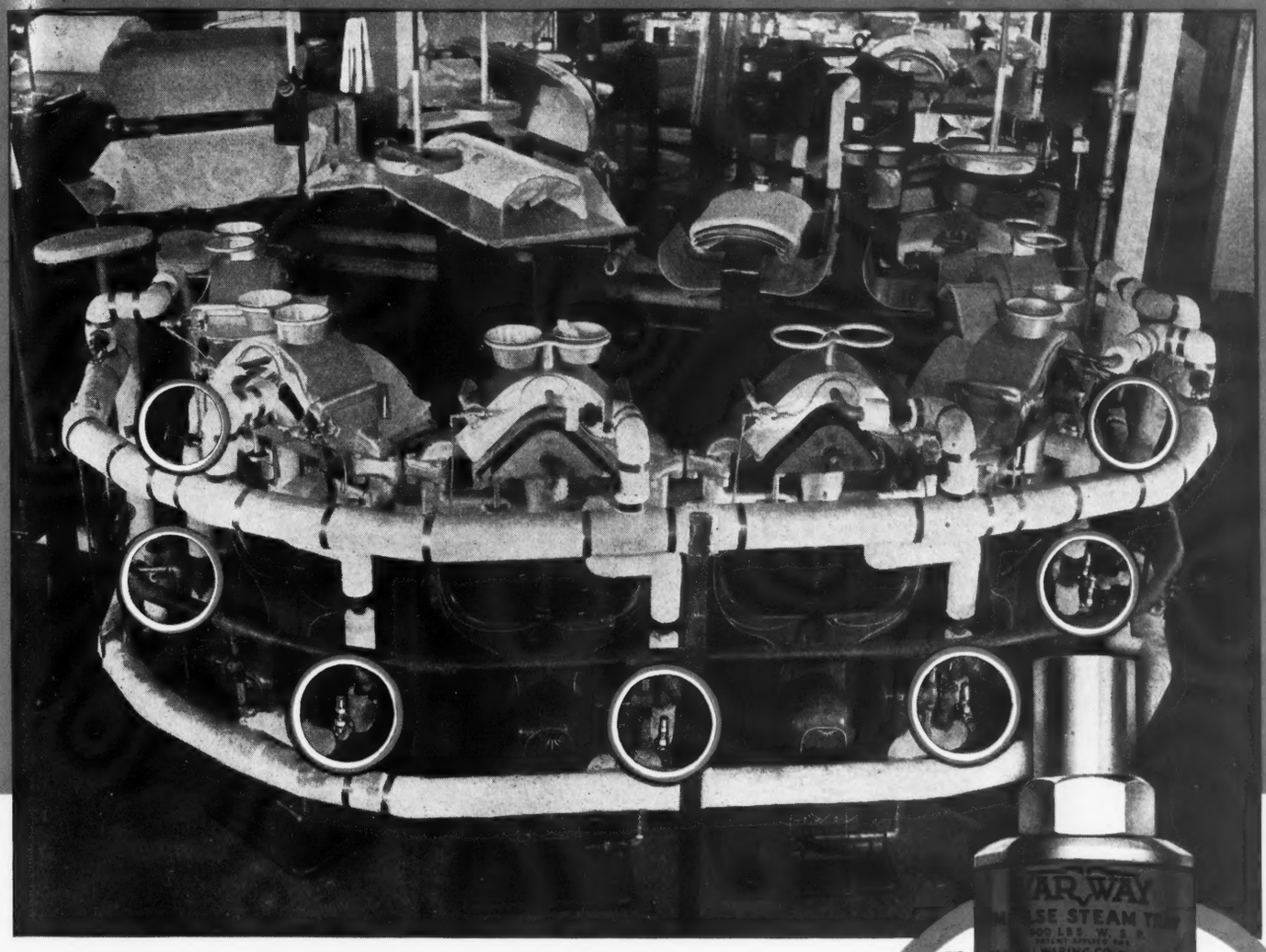
FLOWMETER

"ROTAMETER" has interchangeable precision-bore metering tubes which are as large as pipeline carrying flow. With these interchangeable tubes, any number of rotameters can be made duplicates of each other and spare tubes supplied of same calibration as original tube. Capacity scales are etched into glass and colored pigment is fused into graduations and numerals. Rotation of float said to throw off foreign matter and make meter self cleaning. Range of models from high vacuum to 1,500 lb per sq in. and to meters with tubes over 20 in. long capable of measuring flow ranges of as much as 200 to 1. Recorders, integrators and automatic controller can be supplied; also made for automatic flow-control attachment.

Fischer & Porter Co, 110 W Penn St, Philadelphia, Pa.



71 YARWAY IMPULSE TRAPS
Serve Wanamaker's Laundry



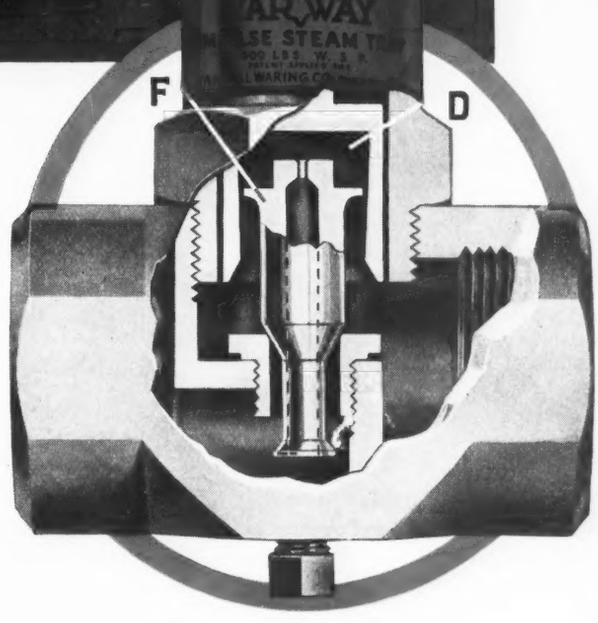
No visitor to Philadelphia has really "done" the city without an hour or two in Wanamaker's great stores. There is an adjunct to these stores, however, that few people see, but all men who know the laundry business recognize it as one of the finest plants of its kind in the whole country . . . Wanamaker's Laundry.

The machines in this laundry are equipped with Yarway Impulse Steam Traps . . . 71 of them . . . traps that are quick and efficient in operation . . . small, light-weight, easy-to-install traps . . . rugged, long-lived traps, of bar-stock construction, with heat-treated Stainless steel valves and seats.

Yarway Traps come in six sizes, from ½" to 2", factory-set for pressures to 400 lbs., to meet practically all requirements. Let us tell you more about them . . . show you why it is usually cheaper to install a new Yarway than to repair an old trap. Write for Catalog T-1721.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

SEE OUR EXHIBIT—CHICAGO EXPOSITION OF POWER & MECHANICAL ENGINEERING
New International Amphitheatre, Chicago, Illinois, October 4 to 9, 1937



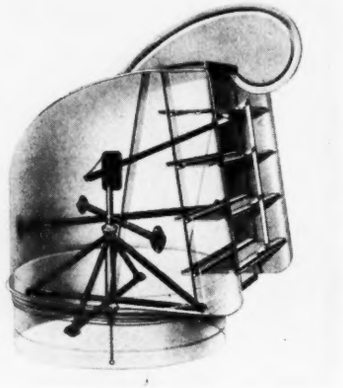
Operation: Movement of valve F is governed by variations in pressure in control chamber D. Hot condensate causes higher pressures, closing the valve. Cooler condensate causes lower pressures, opening the valve.

YARWAY IMPULSE STEAM TRAP

POTENTIOMETER PYROMETER

FOR RECORDING and indicating thermocouple temperatures, pyrometer provides for direct marking on 12-in. roundchart and scale indication on large dial. Operating mechanism consists of highly dampened sensitive galvanometer, pivoted in jewel bearings; relay unit actuated by galvanometer to operate motor that balances electromotive force from thermocouple and positions recording pen arm and scale indicator; standardizing unit; power pack; and potentiometer or recording and indicating units. Made as a recorder, indicator, recorder with indicating scale, recorder controller, and as recorder controller with indicating scale. Either pneumatic or electric types. Bulletin 489.

Bristol Co, Waterbury, Conn.



ROOF VENTILATOR

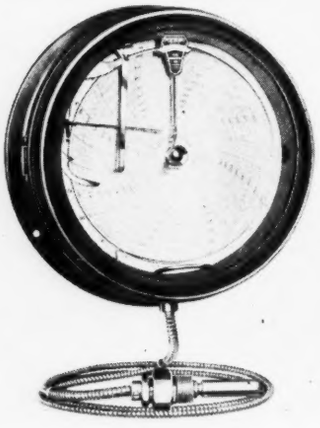
ROTARY roof ventilator has stainless-steel, fully-enclosed, dust-tight, oilless ball bearings upon which head turns with wind. Interior construction of stream-lined steel tubing welded into 1-piece head frame. Throat-diameter sizes from 12 to 72 in. Oversize outlet for extra capacity under all operating conditions.

Swartwout Co, 18625 Euclid Ave, Cleveland, Ohio.

INDICATING AND RECORDING THERMOMETERS

"MONO-THERM" thermometer has thermal system which provides permanent seal for acuating medium. Entire system welded or braised to reduce possibility of leaky joints. Either vapor-pressure, gas-filled, or liquid-filled types. Liquid-filled instrument can be protected against an over-range up to maximum of 500 F; gas-filled instrument against over-range of 100% up to maximum of 1000 F; and vapor-pressure type for a 100% over-range to breakdown point of actuating medium.

Foxboro Co, Foxboro, Mass.



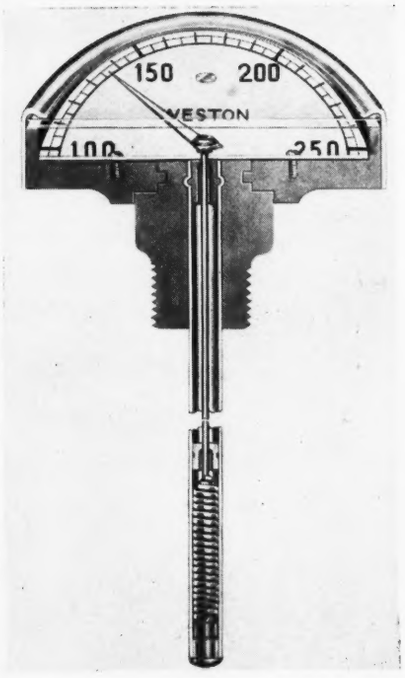
FLOW-CONTROL AND SHUTOFF VALVE

BRONZE "Flocontrol" valves are combination of flow instrument and shutoff valve. Stainless-steel valve steats and disks of 500 Brinell hardness. Union bonnet valve body. For maintaining close manual control on oil-burner lines, water-treating systems, cooling-water lines to turbines and air compressors.

Hancock Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn.

TEMPERATURE GAGES

DIAL-AND-POINTER gages said to be first industrial application of "coil within coils" design for bi-metal temperature-



sensitive element. All-metal temperature element is sheathed within stainless-steel stem. Circular dial case, 3 in. in diameter, mounted at right angles to and at top of stem. For water and oil temperatures of diesels and exhaust-gas temperature of diesels.

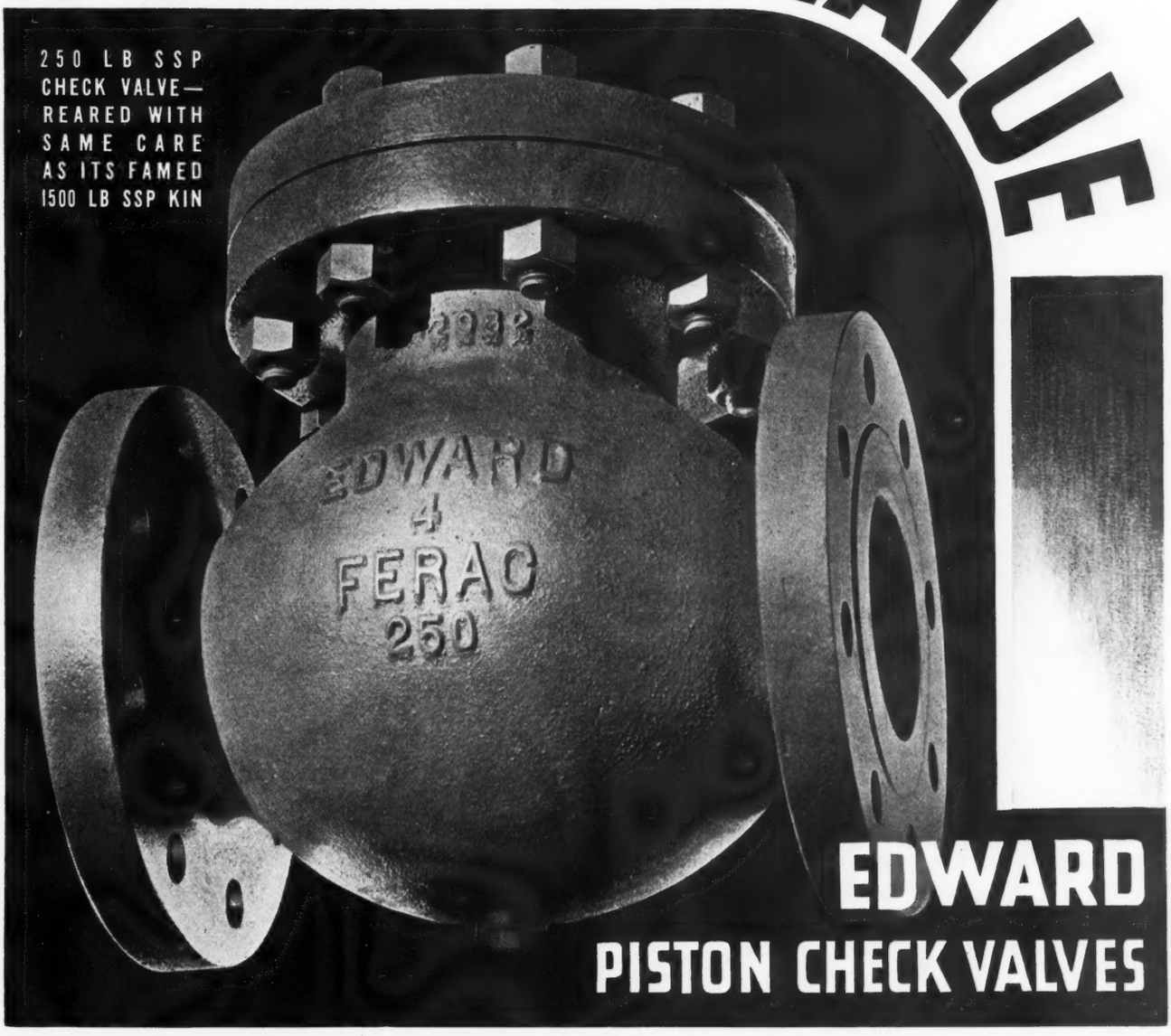
Weston Electrical Instrument Corp, Newark, N. J.

ELECTRIC VALVE

FOR CONTROL of water to air conditioners and humidifiers, Type H valve has special method for attaching BX cable. Lower half of coil housing is empty, which allows wires from BX cable to be pushed into this space after connections are made to coil leads. Then BX sheath is held in place by housing connector.

Supreme Electric Products Corp, Rochester, N. Y.

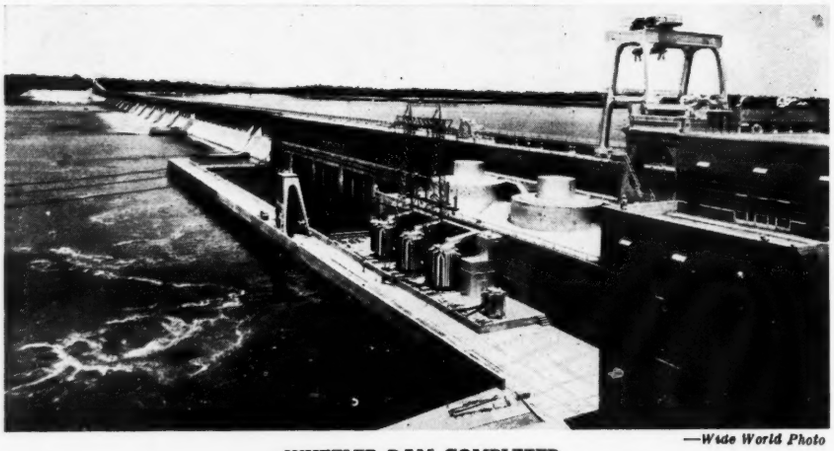
BUILT FOR VALUE



EDWARD
PISTON CHECK VALVES

EVERY Edward sale conforms to the theory that the buyer must profit. Emphasis on this principle of mutual gain has led consistent Edward users to expect, and rightly, plus value for their money. Inherent worth—as evidenced by dependability, minimum upkeep cost and long life—are assured by thoughtful attention to many details, including microscopically exact scrutiny of materials, designs geared to tough service needs, and rigorous tests to eliminate any substandard product. The accent is on inherent strength.

The Edward Valve & Manufacturing Co., Inc.
EAST CHICAGO « « » » INDIANA



—*Wide World Photo*

WHEELER DAM COMPLETED

A view of the downstream face of Wheeler Dam on the Tennessee River, which was formally dedicated by President Roosevelt Sept 10. Its two 45,000-hp outdoor-type generating units are in the right foreground, and outlines of the navigation lock are visible across the river

POWER LINES

New Plants Projected In U. S. and Canada

New plant construction continues at a rapid pace in the utility field. In Pittsburgh, Duquesne Light Co awarded a contract to Westinghouse Electric & Mfg Co for a 60,000-kw turbine-generator and auxiliary equipment for James H Reed station, where an expansion program is now in progress, to be completed late in 1938. The utility has also placed an order with Hagan Corp, Pittsburgh, for complete automatic boiler-control system for two new high-pressure units, designed to develop a capacity of 375,000 lb of steam per hr. Approximately $5,000,000 will be spent on plant addition and equipment.

An $8,000,000 steam plant will go into construction soon for Niagara Electric Co in Buffalo harbor, near Fuhrman Blvd. The new plant will house a single 80,000-kw turbine-generator to operate at 1,200 lb and 900 F.

Looking ahead to 1939, Pres. Thomas N McCarter of Public Service Corp of N.J. has announced a $12,000,000 program which will triple capacity of the Burlington station by addition of a 100,000-kw generator and two high-pressure, high-temperature boilers, and will add a 50,000-kw superposed turbine-generator and two new boilers at Essex station.

Canada

In Canada, an additional power development with an initial capacity of over 160,000 hp and involving an expenditure of some $15,000,000 will be commenced this winter on the Upper St Maurice River by St Maurice Power Corp. Settings will be provided in the power house for six vertical hydroelectric units, four of which will be installed first, leaving two for future development. Each unit will have a capacity of 40,500 hp at a head of 104 ft.

Shawinigan Water & Power Co has started construction of a large power terminal and substation near Three Rivers, Quebec, at a cost of nearly $750,000. The station will contain initially a transformer capacity of 145,000 kva complete with switching equipment. Construction of this station is a major step in the projected development of the Upper St Maurice River which will eventually produce over a million horsepower at present unharnessed on the river from 110 to 175 miles north of Shawinigan Falls.

Welding Society Meets Oct 18-22 in Atlantic City

A record crowd is expected for the 18th Annual Meeting and Exposition of the American Welding Society, to be held in Atlantic City, N.J., Oct 18-22. In addition, concurrently with the AWS convention, the American Society of Metals is holding its 19th Annual Convention in Atlantic City.

C A McCune, chairman of the AWS convention committee, states that "more than 15,000 executives, engineers, metallurgists and welding men will gather for the meeting and exposition. Papers will be presented on practical applications of welding in fabrication, railroad, ship-building and other fields. A welding symposium on alloy steels is expected to draw large audiences."

Diesel Users' Assn Formed in America

At its first annual meeting, held Aug 23 at State College, Pa., the newly organized Diesel Users' Assn of America elected the following officers: president, H C Major, commissioner of public utilities, Rockville Center, N.Y.; vice-president, C W Welsh, chief engineer, Otter Tail Power Co, Fergus Falls, Minn.; secretary, Louis Black, chief engineer, Doubleday, Doran & Co, Inc, Garden City, N.Y.

These officers, together with R G Chester, chief engineer, Vernon, Calif., plant of Southern California Edison Co, Ltd; Southmayd Hatch, Marine Transportation Dept, Socony-Vacuum Oil Co, Inc, New York, N.Y.; and R G Williams, city manager, Bryan, Texas, will constitute the board of directors of the organization.

The Association will shortly appoint a Publication Committee. Also, active steps will be taken to enroll all engineers able to qualify for membership. Present address of the Association is 7 West 44th St, New York, N.Y.

Power Transmission Council Meets in N. Y.

A 5-point plan incorporating the aims of the Power Transmission Council to further its service to industry was emphasized at a meeting and banquet of the N.Y. and N.J. branches of the organization held at the Hotel Astor, New York, N.Y., September 10. More than 400 were present. The 5-point program provides for national organization, sound engineering, regional engineering staffs, local engineering and sales organizations, and effective merchandising.

Charles E Brinley of American Pulley Co, and chairman of the Council, presided at the meeting. Speakers included J H Van Deventer, editor of *Iron Age*, "New Economic Problems Create New Opportunities"; and Victor A Hanson, vice-president and chief engineer of the Council, "Where Motors are Used to Advantage".

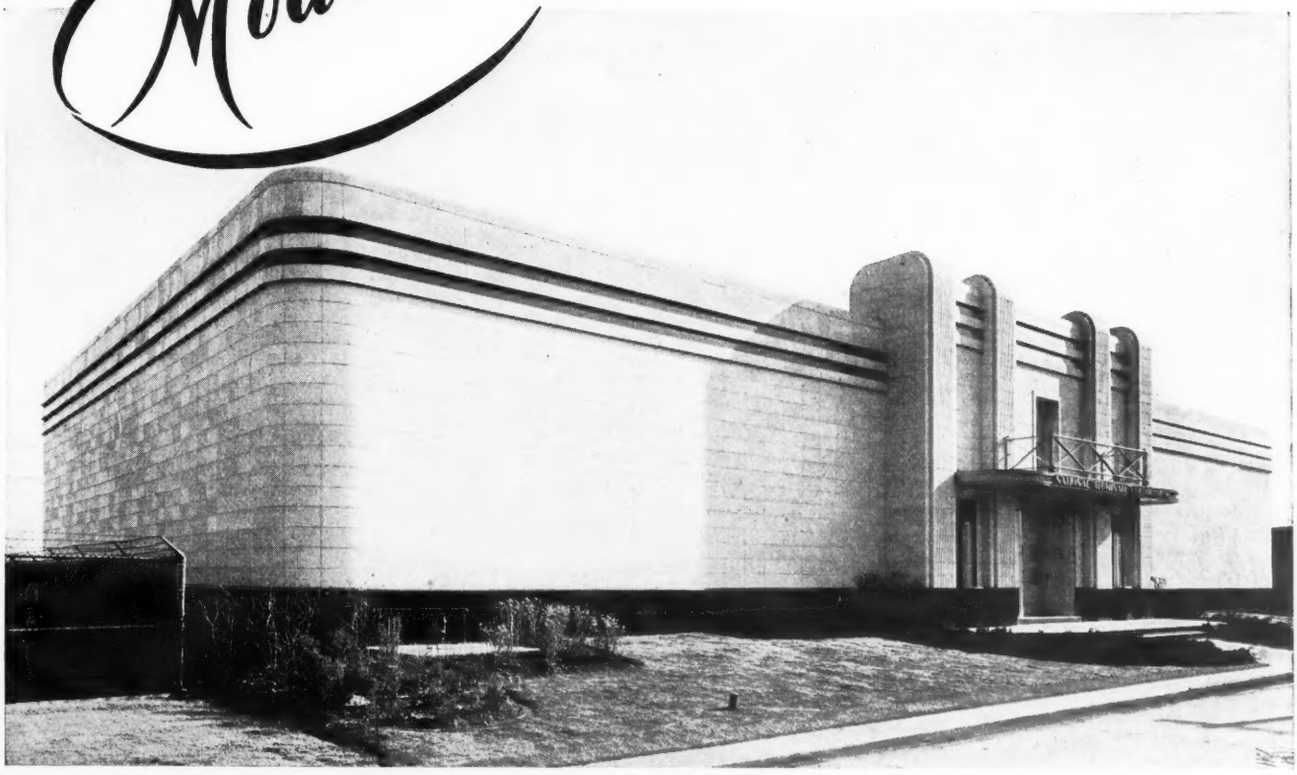
Chicago Power Show Opens October 4

The Chicago Exposition of Power & Mechanical Engineering will focus the national spotlight on machine and power developments in the Midwest, where it has never been similarly focused before. Exhibits by leading manufacturers (see exhibitors list) will be displayed at the International Ampitheatre during the Show, Oct 4 to 9.

No admission fee will be charged; admission will be by invitation and registration only. Registration for admittance may be made at the entrance to the Amphitheatre while the Exposition is in progress.

Products exhibited will include: transmission apparatus; control equipment; piping, valves and fittings; generating equipment; electrical apparatus; air-conditioning and refrigerating equipment; materials handling; metals and alloys; machines; refractories; specialties; and textbooks and periodicals active in the field of power pro-

Modern!



Architect: Ambrose C. Cramer, Inc., Chicago

MODERN power plants require modern, up-to-date water treatment. The Nalco System of Feedwater Treatment is as modern as its new office and laboratory shown above. This new building (windowless, air conditioned, and soundproofed) with the latest laboratory equipment and facilities for research enables Nalco to give even finer service to an ever-increasing roll of customers. We will be glad to give you complete information about the Nalco System. Write today, or better still ask a Nalco customer!

AN interesting, illustrated booklet describing this unique building has been prepared. We will be glad to send you a copy on request.

NATIONAL ALUMINATE CORPORATION
6222 W. 66th Place Chicago, Illinois

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico*, should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, England. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay Street, Toronto, Ontario.

duction and mechanical engineering.

The Show opens Monday, Oct 4, at 2 PM, and on succeeding days is open from noon to 10:30 PM. It closes Saturday, Oct 9 at 6 PM.

Air-Conditioning Course Offered by G E

An extensive educational program designed to attract young men into the air-conditioning industry has been started by General Electric Co. The program will be worked out through its field distributors for graduates of colleges, technical schools and high schools.

Practical manuals, courses and training activities have been designed by G E's air-conditioning department, to be augmented by various forms of instruction on the field by district managers and factory men. Applications for training should be made to distributors or to G E Air Conditioning Div headquarters in Bloomfield, N. J.

Heat-Control Film

Johns-Manville recently released a film "Heat and its Control", designed to help visualize the nature of heat and to illustrate heat transfer by radiation, convection and conduction. The picture will be shown at engineering-society meetings and at special showings to other interested groups. All arrangements for such programs will be handled by Johns-Manville district representatives.

S A Tucker

POWER STAFF CHANGES

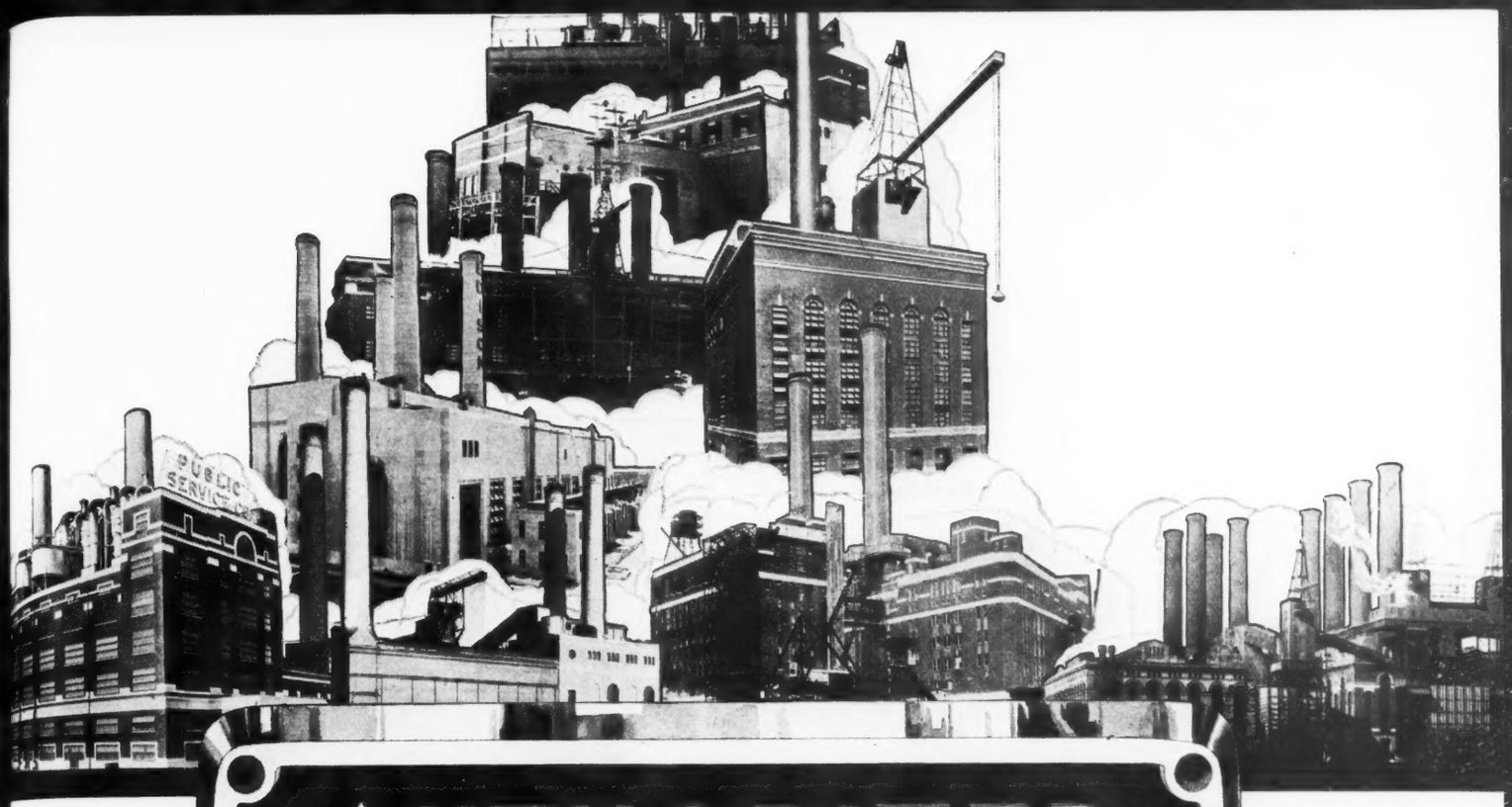
Stanley A Tucker, electrical engineering graduate of Yale Sheffield Scientific School in 1926, has joined the staff of *Power* as associate editor. Following graduation, he went directly to Brooklyn Edison Co, where he spent two years in the Cadet Engineer course in various departments. On completion of the course, he entered the Mechanical Engineering Department as junior engineer.

A year later he was placed in charge of the General Engineering Division, responsible for economic and equipment evaluation studies and heat balance for Hudson Ave. Station. This gave him a wide range of experience in handling engineering problems of all sorts, particularly in finding the answers to the many small questions that plague any engineering department—excellent training for an editor who must answer hundreds of questions each year. It also brought him into close contact with the ASME and the Prime-Movers Committee, EEI.

With the merger of the Engineering Departments of metropolitan companies early in 1937, Mr. Tucker was transferred to the Mechanical Engineering Department of Consolidated Edison Co of New York, where he worked directly under E B Ricketts. Mr. Tucker re-

LIST OF EXHIBITORS, CHICAGO POWER SHOW

431–433	Ahlberg Bearing Co
515–517	Allen-Bradley Co
6–7	American Air Filter Co
3	American Brass Co
539	American Chain & Cable Co
217–19–21	American Engineering Co
4	American Metal Hose Div, American Brass Co
57–58	American MonoRail Co
50	American Pulverizer Co
105	Armstrong Bray & Co
105	Armstrong Bros Tool Co
129–131	Armstrong Machine Works
442	Badger, E B & Sons Co
130–132	Barrett-Christie Co
113–115	Barrett-Cravens Co
524	Beaver Pipe Tools Inc
	Becker Brothers Carbon Co
220	Bird-Archer Co
52–53	Boston Gear Works Inc
505	Brett Machinery Co
119	Breuer Electric Mfg Co
422–424	Bridgeport Brass Co
240	Carrier Corp
209–211	Caterpillar Tractor Co
516	Chicago Metal Hose Corp
311	Chicago Rawhide Mfg Co
242	Clements Mfg Co
344	Clersite Company Products
404	Cleveland Worm & Gear Co
227	Clipper Belt Lacer Co
507	Coe Manufacturing Co
317	Coffing Hoist Co
218	Columbia Vari-Speed Co
328	Connery Construction Co
446	Continental Mch Specialties Inc
1–2	Crane Co
427–429	Cutler-Hammer Inc
428–430	Dayton Rubber Mfg Co
139	Dayton Rogers Mfg Co
505	Detroit Power Screwdriver Co
421	Dixon, Joseph Crucible Co
505	Economy Tool & Machine Co
51	Edward Valve & Mfg Co
434	Ehret Magnesia Mfg Co
509	Elgin Softener Corp
442	Engineering Sales Co
319–321	Fafnir Bearing Co
212	Faville-Levally Corp
527	Foley Manufacturing Co
339	Forty-Eight Insulations Inc
223	Garlock Packing Co
134	General Electric Vapor Lamp Co
521–523	Graham Transmissions
409	Green, A P Fire Brick Co
305	Grinnell Company Inc
503	Grob Brothers
118	Haering, D W Co Inc
417–419	Hamilton Manufacturing Co
309	Hammett Elec Arc Welder Co
505	Hamilton Tool Co
336	Hays Institute of Combustion
327	*Heating, Piping & Air Conditioning*
538	Independent Air Filter Co
423	*Industrial Power*
309	Jackson Electrode Holder Co
432	Janette Mfg Co
204–208	Jenkins Bros
232–234	Johns-Manville
140	Johnson Bronze Co
132	Johnson Corp
309	Johnson Welding Equip Co
50	Johnston & Jennings Co
	Stowe Stoker Div
314–316	Jones & Laughlin Steel Corp
322–324	Keasbey & Mattison Co
327	Keeney Publishing Co
318–320	Keuffel & Esser Co
507	Kramer, Fred C Co
543	Kron Co The
304	Link-Belt Co
210	Louden Machinery Co
133	Lovejoy Flexible Coupling Co
339	Mayer & Oswald Inc
510	Mercury Mfg Co
339	Meriam Co, The
111	*Mill and Factory*
222–224	Modine Mfg Co
505	Moore Special Tool Co
110–112	Morse Chain Co
312	Motor Improvements Inc
243	Nathan Mfg Co
329	National Aluminate Corp
309	National Cylinder Gas Co
120–122	Norma-Hoffmann Bearings Corp
443	Nutting Truck Co
536	Oilgear Co
436	Oster Mfg Co
413–415	Parker Appliance Co
207	Plibrico Jointless Firebrick Co
108	POWER
323	*Power Plant Engineering*
442	Prat-Daniel Corp
528	Ramtite Co
539–541	Reading, Pratt & Cady Div American Chain & Cable Co
412	Reeves Pulley Company
50	Reintjes Geo P Co
512–514	Revere Copper & Brass Inc
114–116	Rhoads, J E & Sons
530–532	Ric-wiL Co
420	Ridge Tool Co
310	Rivett Lathe & Grinder Inc
505	Robbins Engineering Co
533	Rockwood Mfg Co
345	Safety Belt Lacer Co
124	Sarco Company Inc
143	Schieren, Chas A Co
313–315	Schundler, F E & Co Inc
228–230	SKF Industries Inc
50	Skeen, D H & Co
309	Smith Welding Equip Co
229	Snap-On Tools Inc
435	South Bend Lathe Works
216	*Southern Power Journal*
219–221	Staynew Filter Corp
123–125	Steel and Tubes Inc
212	Stock Engineering Co
142	Strand, N A & Co
213	Sullivan Machinery Co
542	Talcott, W O & M W Inc
502–504	Timken Roller Bearing Co
127	Titeflex Metal Hose Co
511	Toledo Pipe Threading Mch Co
117	Trabon Engineering Corp
141	Trerice, H O Co
144	Veeder-Root Inc
518–520	Walworth Co
244	Ward Leonard Electric Co
346–445	Wells Manufacturing Corp
534	Westinghouse Elec & Mfg Co
246	Weston Electrical Inst Corp
212	Wheeler, C H Mfg Co
339	Wing, L J Mfg Co
414	Wolverine Tube Co
8	Wright-Austin Co
55	Yale & Towne Mfg Co
5	Yarnall-Waring Co
506–508	Youngstown Sheet & Tube Co



AUTHORIZED USER OF HALL SYSTEM

1,613,656 PATENTED 1,613,701

Up and down the land . . . on the high seas . . . in thousands of fine boiler-plants everywhere, you will find this symbol of protection. To all, it says "These boilers operate now as their builders intended. Efficiency is the watch-word in this plant; boiler-scale, corrosion, embrittlement and wet steam cannot enter here." Do you have our latest Bulletin on water conditioning? If not, —write the Buromin Company or Hall Laboratories at the address below.

HALL LABORATORIES

A Subsidiary of Hagan Corporation

300 ROSS STREET · PITTSBURGH, PA.

L N Rowley, Jr.

places R B Purdy, who resigned from *Power* to join *Diesel Power* last May 1, and will be principally responsible for articles dealing with high-pressure steam and central-station practice.

Louis N Rowley, Jr, graduated from Brooklyn Polytechnic Institute in 1931 with a mechanical engineering degree and since that time with Brooklyn and Consolidated Edison Companies, has also joined *Power* as assistant editor. Following graduation, he spent two years on the engineer training course with Brooklyn Edison, and since that time has been in the engineering and construction departments, engaged in inventory of mechanical equipment, general engineering in connection with selection of equipment, etc. He has been active in several ASME committees.

Mr. Rowley replaces S H Coleman, who was connected with *Power* for a short time late in 1936.

ASME Fall Meeting In Erie, Pa., Oct 4-6

First ASME Fall Meeting will be held in Erie, Pa., Oct 4-6. Headquarters will be at the Hotel Lawrence.

Ten professional divisions are cooperating with the Erie Local Section in providing papers for the meeting. In addition to twelve technical sessions covering power, railroads, machine-shop practice, fuels, management, petroleum, processing, instruments, and cutting of metals, there will be a banquet and a number of organized visits to important plants in Erie.

The session on power will include "New Metal for High-Temperature Service", by Roger S Brown and C L Clark, and "Rehabilitation of Station No. 3, Rochester Gas & Electric Corp", by R H Boas.

OBITUARIES

PROF HERMAN DIEDERICHS, 63, dean of the College of Engineering, Cornell University, died Aug 31. Dean Diederichs, for many years professor of experimental engineering and director of the Sibley School of Mechanical Engineering, was associated with Cornell for almost 40 years. He began his university career in 1898, became assistant professor four years later, full professor in 1907, and dean of the college last year.

CHARLES P WOODWORTH, 56, vice-president of Weber Chimney Co, Chicago, died recently. He had been in poor health for a number of years, and had not been active in business since 1934.

GEORGE W FOWLER, 61, Chicago office manager of New Departure Div of General Motors Corp, died August 9 after an extended illness.

FRED M INGERSOLL, 74, who retired a year ago after 35 years of service as engineer at West Gloucester, Mass., pumping plant, died at his home in Gloucester, Aug 29.

CHARLES NEAVE, 69, member of the Board of Directors of General Electric Co, died Sept 10 at his home in Ossining, N.Y.

MEETINGS

American Welding Society—*18th Annual Meeting and Exposition, Oct. 18–22, Hotel Traymore and Convention Hall, Atlantic City, N. J. Miss M. M. Kelley, secretary, 33 W. 39th St., New York, N. Y.*

American Society of Mechanical Engineers—*Fall Meeting, Oct. 4–6, Erie, Pa. C. E. Davies, secretary, 29 West 39th St., New York, N. Y. Also A.S.M.E. Annual Meeting, Dec. 6–10, New York, N. Y.*

A.S.M.E. and A.I.M.E. Fuels Conference—*Joint Meeting, Oct. 27–28, Pittsburgh, Pa. C. E. Davies, A.S.M.E. secretary, 29 West 39th St., New York, N. Y.*

Chemical Industries—*Sixteenth Exposition, Dec. 6–11, New York, N. Y. Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.*

Chicago Exposition of Power & Mechanical Engineering. *International Ampitheatre, Chicago, Ill., Oct. 4–9. Address Charles F. Roth, vice-president of International Exposition Co., Grand Central Palace, New York, N. Y.*

Heating, Ventilating and Air Conditioning—*Fifth International Exposition, Jan. 24–28, 1938, New York, N. Y. Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.*

International Acetylene Association—*38th Annual Convention, Nov. 10-12, Birmingham, Ala., Hotel Tutwiler, Assn. headquarters, 30 E. 42nd St., New York, N. Y.*

National Safety Council—*Annual Meeting, Oct. 11–15, Kansas City, Mo. W. H. Cameron, secretary and managing director, 20 N. Wacker Drive, Chicago.*

National Society of Professional Engineers *Annual Convention, Oct. 8-10, Hotel Commodore, New York, N. Y. Chairman, F. H. Zurmuhlen, 33 Liberty St., New York, N. Y.*

PERSONALS

JOHN H LENAERTS, formerly a member of the engineering staff of Stone & Webster Engineering Corp and of Harry M Hope Engineering Corp, and for 10 years chief engineer of Hood Rubber Co, Watertown, Mass., has been appointed special representative in the general sales department of Foster Wheeler Corp, New York, N.Y.

W A NEILL has been appointed manager of engineering and sales by Worthington Pump & Machinery Corp for its recently reopened plant at Holyoke, Mass. Mr. Neill was formerly manager of Worthington's Air Tool & Compressor Div at Harrison, N.J.

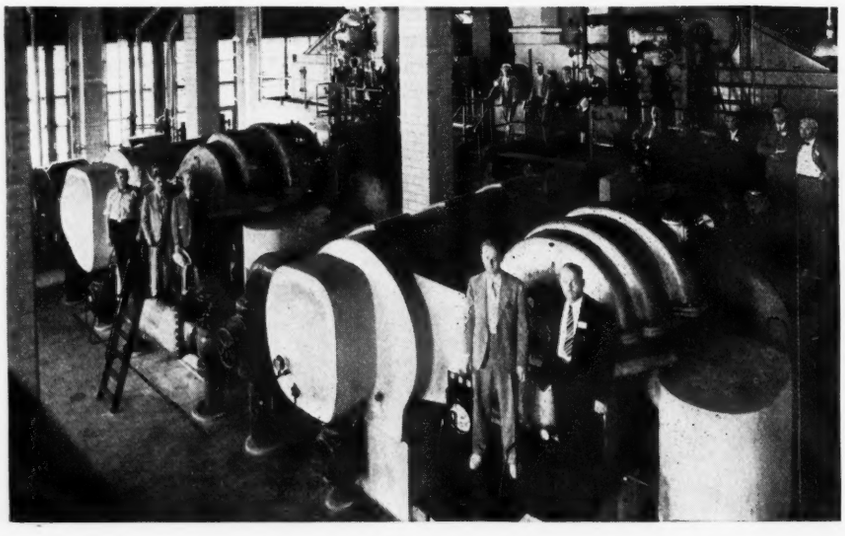
P C DAY has been elected vice-president of Falk Corp, Milwaukee, Wis. Mr Day has been chief engineer of Falk Corp since 1910.

MAX H SCHACHNER has been named assistant sales manager of Winton Engine Corp, subsidiary of General Motors. His principal responsibility will be direction of sales of Winton 2-cycle diesels.

I B VAN HOUTEN, formerly advertising manager of Raybestos Co, has been appointed advertising manager for Man-

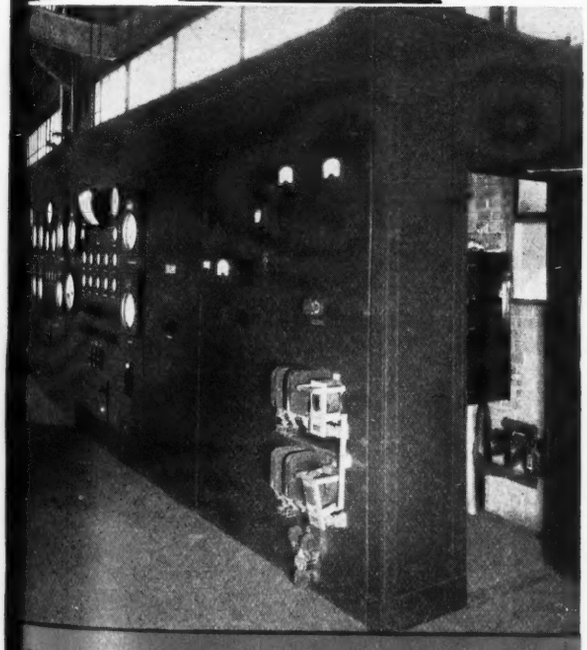
CENTRIFUGAL COMPRESSORS

Carrier Corp engineers inspect installation at Schaefer Brewery, Brooklyn, N. Y., of recent 650-ton centrifugal-refrigeration installation. This equipment supplies all demands of the brewery for refrigeration, and is designed as a part of the entire heat-balance system



IF YOU CHOSE, YOU COULD TURN

THE GAUGE TO THE WALL !



A typical Hagan Control Installation in a large steel mill

IN the Hagan System, instruments are merely *proof* of efficient combustion control—not part of it. The control itself *determines* what is going on; the instruments simply furnish a visual record of what has happened.

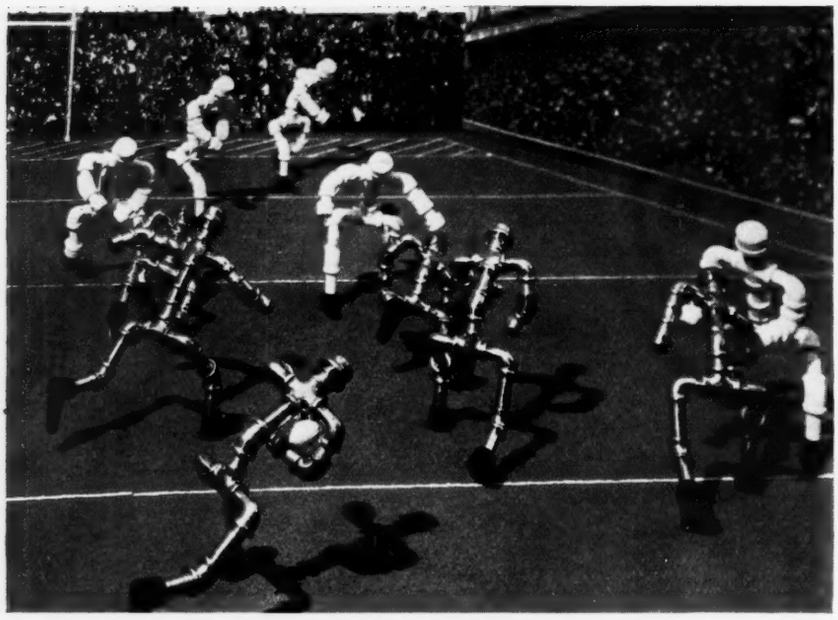
You could turn them face to the wall, except for their valuable function of indicating any change from the desirable. And *that* they do straight-forwardly and honestly, without pre-supposing that any one factor is basically responsible for a change which they indicate.

Make no mistake about it, the CONTROL is the thing . . . the accurate automatic adjustment of every combustion factor that is characteristic of Hagan installations all over the world. Twenty years of pioneering leadership place Hagan *first* in the consideration of anyone planning a modern combustion-control installation.

HAGAN COMBUSTION CONTROL

HAGAN CORPORATION

300 ROSS STREET, PITTSBURGH, PENNA.



HOLD THAT LINE!

It's October again and football season. The brass fittings team executes an end run with well-nigh perfect blocking—a display of robot-like figures in a traditional gridiron setting which Crane Co, Chicago, is showing at cities where major football games are being played this Fall.

ning, Maxwell & Moore, Inc, Bridgeport, Conn., which includes its four divisions: Consolidated safety valves, Ashcroft American gages, American Schaeffer & Budenburg instruments, and Hancock valves.

R A McCLEVEY has been made vice-president and general manager of Murphy Diesel Co, Ltd, Milwaukee, Wis. Mr. McClevey was secretary of the Northern Illinois Coal Trade Assn from the time of its formation until the present time.

NEWLY appointed officers of Chapman Valve Mfg Co, Indian Orchard, Mass., are John J Duggan, president, and Frederic C Low, treasurer. Mr. Duggan succeeds Thomas F Maher, recently deceased, and Mr Low, who has been cost accountant and office manager, succeeds Mr Duggan as treasurer.

M E NICKLIN, export sales manager of Waukesha Motor Co, has resigned to return to the oil industry as assistant to W C Ramsey, manager of the Machinery Div, Oil Well Supply Co, Oil City, Pa. Max Hoffman, with Waukesha since 1926, succeeds Mr. Nicklin as Waukesha export sales manager.

ROBERT E DILLON, for the past 12 years superintendent of the Generating Department of Boston Edison Co, has been elected vice-president in charge of production. He joined the company's staff in 1910 after being graduated from Massachusetts Institute of Technology, working in the Edison laboratory prior to engaging in operating practice. His term of service has been closely identified with development of the system, including the Edgar station and improvements at L Street plant.

COL JULIAN L SCHLEY will become Chief of Engineers of the U. S. Army with the rank of Major General, effective Oct 18. Col Schley was recently engineer of maintenance and later Governor of the Panama Canal. The Madden Dam was built during his administration; he organized the design office and started studies for the third series of lock chambers.

In 1921 and 1922, Col Schley was in charge of the Nashville Engineering District, where he had charge of improvement and maintenance on the Tennessee River below Wilson Dam.

A C COLE, since 1932 plant engineer of the Light & Power Dept, Regina, Saskatchewan, recently resigned to become superintendent of the Saskatchewan Power Commission's power plant

at Saskatoon. For the 10 years 1922 to 1932, Mr. Cole was associate editor of *Power*, and before that, chief engineer of the Regina power plant. On his return to Regina from *Power*, he devoted most of his time to improving operation of the high-pressure steam plant and to engineering work connected with a new steam-generating unit to supply 150,000 lb of steam per hr at 400 lb g and 825 F.

BUSINESS ITEMS

LINDE AIR PRODUCTS Co, opened a new sales office in Oakland, Calif., at 3710 San Pablo Ave., Sept 1, bringing number of Linde offices throughout the country to a total of 33.

D W HAERING & Co, Chicago, has made the following appointments in personnel: Joseph Mallock as district manager of Michigan with headquarters in Detroit; B S Coop as district manager for the South with headquarters in Atlanta, Ga.; Guy Hamilton as district manager for Tennessee, with headquarters in Nashville; and addition of D F Mortara, chemical engineer, and D C Suhr, civil engineer, to its Chicago staff.

D H SKEEN & Co, Chicago, Ill., has been appointed representative of Strong-Scott Mfg Co, Minneapolis, for "Unipulvo" direct-firing system for boilers.

HARNISCHFEGER CORP, Milwaukee, has appointed C H Boning, Youngstown, N.Y., as P & H sales engineer for western New York.

BABCOCK & WILCOX TUBE Co, Beaver Falls, Pa, has appointed Ulrich Supply Co, Kansas City, Mo., as distributors of B & W boiler tubes for western Missouri and Kansas.

IRON & STEEL PRODUCTS, INC, Chicago, has engaged Jack Ryan, for many years with The Texas Co, and Bill Rosser, formerly with Symington Corp and lately with Bradford Corp, as special sales representatives in Chicago.

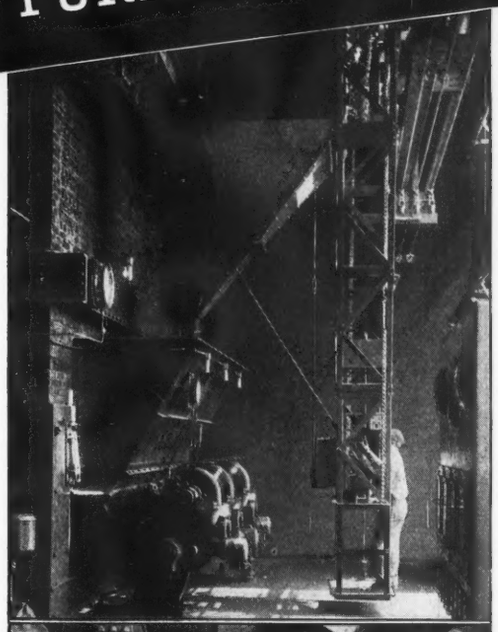
WILLIAM B SCAIFE & SONS Co, Pittsburgh, Pa., has named Karl P Fuhrman as general sales manager. Mr. Fuhrman was formerly manager of Range Boiler & Tank Division of Wheeling Steel Corp.

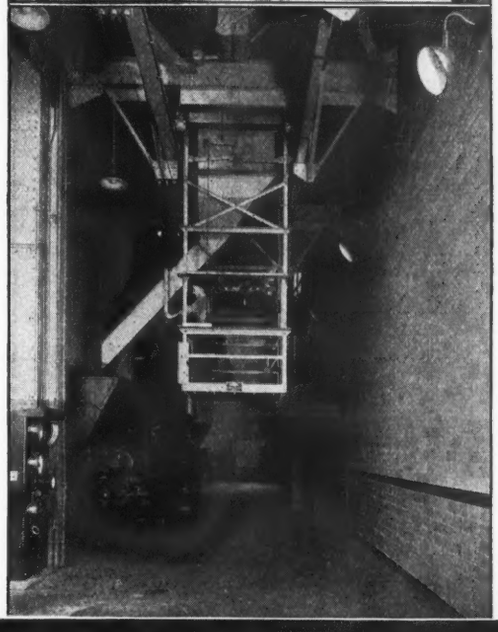
BLAW-KNOX Co, Pittsburgh, announces appointment of G Howard Boddy, whose headquarters are in General Motors Bldg, Detroit, as representative for engineering and sales of Power Piping Corp products.

MARLEY Co, Kansas City, Mo., has opened a West Coast branch at 1144 S Grand Ave., Los Angeles, with Robert K Leilich in charge.

ALLEN-BRADLEY Co, Milwaukee, has appointed the newly formed Delavan Engrg Co, 414 12th St, Des Moines, Iowa, as representative for Iowa; and Wilson Electrical Equipment Co, 2009 Capitol Ave., Houston, Tex., as representative in southern Texas.

BARTLETT · SNOW WEIGH LARRIES ELIMINATE SEGREGATION · INCREASE STOKER AND FURNACE LIFE ★ ★ ★





● Reflecting in their design 35 years of intimate customer experience, Bartlett-Snow Weigh Larries enable operators to keep accurate records of the fuel consumption of each boiler—and promote ideal combustion.

Coal discharged from a fixed chute segregates. Fines remain in the center. Lumps seek the sides. Uneven passage for the air, and uneven draft results. The gases burn hottest on the sides—scoring the furnace walls and burning out the stokers.

Bartlett-Snow Weigh Larries correct this condition. The operator loads the larry—records the weight on a permanent card form . . . and moves the larry back and forth *while it is being unloaded.* Even distribution of lumps and fines is secured . . . segregation is avoided. Operating efficiency goes up. Steam costs and maintenance charges down.

Full details of Bartlett-Snow ½–¾–1 and 2 ton standard and special larries will be found in Bulletin 73. Copies will be sent on request. Send for one.

THE C. O. BARTLETT & SNOW CO.
6205 Harvard Avenue Cleveland, Ohio
In New York—30 Church Street
In Chicago—First National Bank Building

BULLETIN No. 73

Complete with 44 diagrams, 12 tables, 90 illustrations describes the Bartlett-Snow method of securing less costly—more efficient operation. Send for one.

BARTLETT · SNOW
Coal and Ash Handling Equipment

TRACK HOPPERS • LOADING GATES • SKIP HOISTS • HOIST ENGINES
BUNKERS • WEIGH LARRIES • ASH HOPPERS • FIELD STORAGE

CUTLER-HAMMER, INC, Milwaukee, Wis., has appointed Joseph Gardberg manager of their new office at 539 Gravier St, New Orleans, La.

LINCOLN ELECTRIC Co, Cleveland, Ohio, has opened a new sales engineering office at 400 North St, Bluefield, West Va., headed by William H. Schuster. Walter D Wood, Jr, has been appointed to the sales staff of the Philadelphia office.

METALLIZING ENGINEERING Co, INC, New York, N. Y., announces the following sales and engineering-staff promotions: W C Reid, formerly Midwestern manager with offices in Chicago, has been appointed vice-president in charge of sales with headquarters at the main office in New York; Walter B Meyer, formerly manager of the St. Louis Office, becomes Chicago manager; and Alan B Geuder, formerly connected with the Chicago office as salesman, succeeds Mr Meyer.

ROOTS-CONNERSVILLE BLOWER CORP, Connersville, Ind., has announced appointment of W E Burke, Waltham, Mass., as turbine-pump sales representative for New England; also, Warren E Quillman for Virginia, Delaware, Maryland, southern New Jersey, and eastern Pennsylvania.

MEN AT WORK!

***Right*—Craftsman in plant of The Hays Corp, Michigan City, Ind, puts finishing touches on a portable gage**

•

***Lower left*—Albert F Spitzglass, vice-president in charge of engineering, Republic Flow Meters Co, Chicago, puzzles over a knotty control problem**

•

***Lower right*—Mind, hand and eye help the machine turn out an endless stream of mechanical-transmission links at Diamond Chain Plant, Indianapolis, Ind.**

STRAWS

Pointing the way business winds blow

ALABAMA——Bossier City plans municipal light and power plant. Cost close to $200,000.

ARIZONA —— Southwestern Ice & Cold Storage Co, Yuma, plans rebuilding portion of ice plant recently damaged by fire. Loss over $40,000.

CALIFORNIA —— Pacific Fruit Express Co, 85 Second St, San Francisco, is considering rebuilding ice and precooling plant at North Power, near Baker, Ore., recently destroyed by fire. Loss estimated close to $30,000.

Schmidt Lithograph Co, 2nd and Bryant Sts, San Francisco, plans boiler house in connection with 6-story and basement plant addition. Cost about $50,000 for boiler plant. Jesse Rosenwald, 525 Market St, consulting enginner.

Oceanside-Carlsbad Union High School District, Oceanside, plans 1-story boiler plant 27x33 ft. Cost about $35,000. T. C. Kistner, Architects' Building, Los Angeles, architect.

COLORADO——Englewood is considering municipal electric plant. Estimates of cost soon.

Colorado Springs plans extensions in municipal gas distributing system. E. L. Mosely, city manager.

FLORIDA——Orlando Utilities Commission, Orlando, closes bids Oct. 4 for equipment for municipal light plant, including one 10,000-kw turbine generator, 15,000-sq ft high-pressure boiler and auxiliaries, $650,000 authorized. Robert & Co., Bona Allen Bldg, Atlanta, Ga., consulting engineers.

Chattahoochee plans municipal power plant, to include two 750-kw turbine-generator, two 5,110-sq ft boilers and auxiliaries. A water filtration plant will be installed. Also, plans under way for municipal cold storage and refrigerating plant. Entire project will cost about $400,000, with equipment.

ILLINOIS——Swift & Co., Union Stock Yards, Chicago, plans 1-story power house at St. Boniface, near Winnipeg, Man., for its subsidiary, Swift Canadian Packing Co, Winnipeg.

State Prison Dept, State Capitol Bldg, Springfield, has authorized extensions in power house at Illinois State Penitentiary, Joliet.

Chicago, Burlington & Quincy Railroad Co, Chicago, has approved plans for 1-story power house at yards at Lincoln, Neb. Cost close to $40,000.

E. I. duPont deNemours & Co, 2120 Elston Ave, Chicago, contracted C. O. Henriksen Co for 1-story boiler house addition at local chemical plant, 32x32 ft. Cost over $45,000.

INDIANA——Crawfordsville plans improvements in municipal power plant and waterworks station, including 5,000-kw turbine-generator, pumping machinery and accessories. Cost about $285,000.

IOWA——Morning Sun plans municipal light plant to include diesel-generator units. $55,000 through Federal aid.

State Board of Control, State House, Des Moines, has authorized 1-story boiler plant at State Hospital at Cherokee. Cost about $95,000. Henry J. Liebbe, state architect.

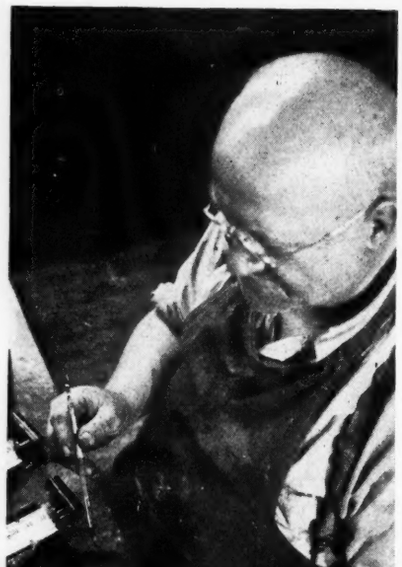
Indianola contracted Fairbanks, Morse & Co, Chicago, for 750-bhp diesel-generator unit and auxiliaries for municipal electric plant, at $71,854.

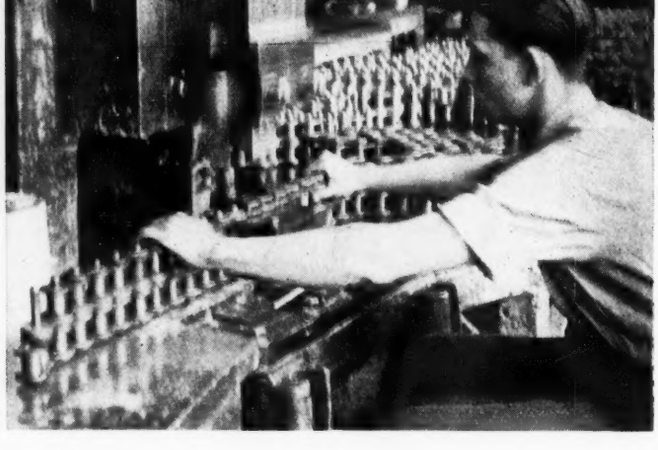
Greenfield will place contracts soon for 400-hp diesel-generator unit, exciter, oil tank, oil filters and coolers, pumps for municipal power plant.

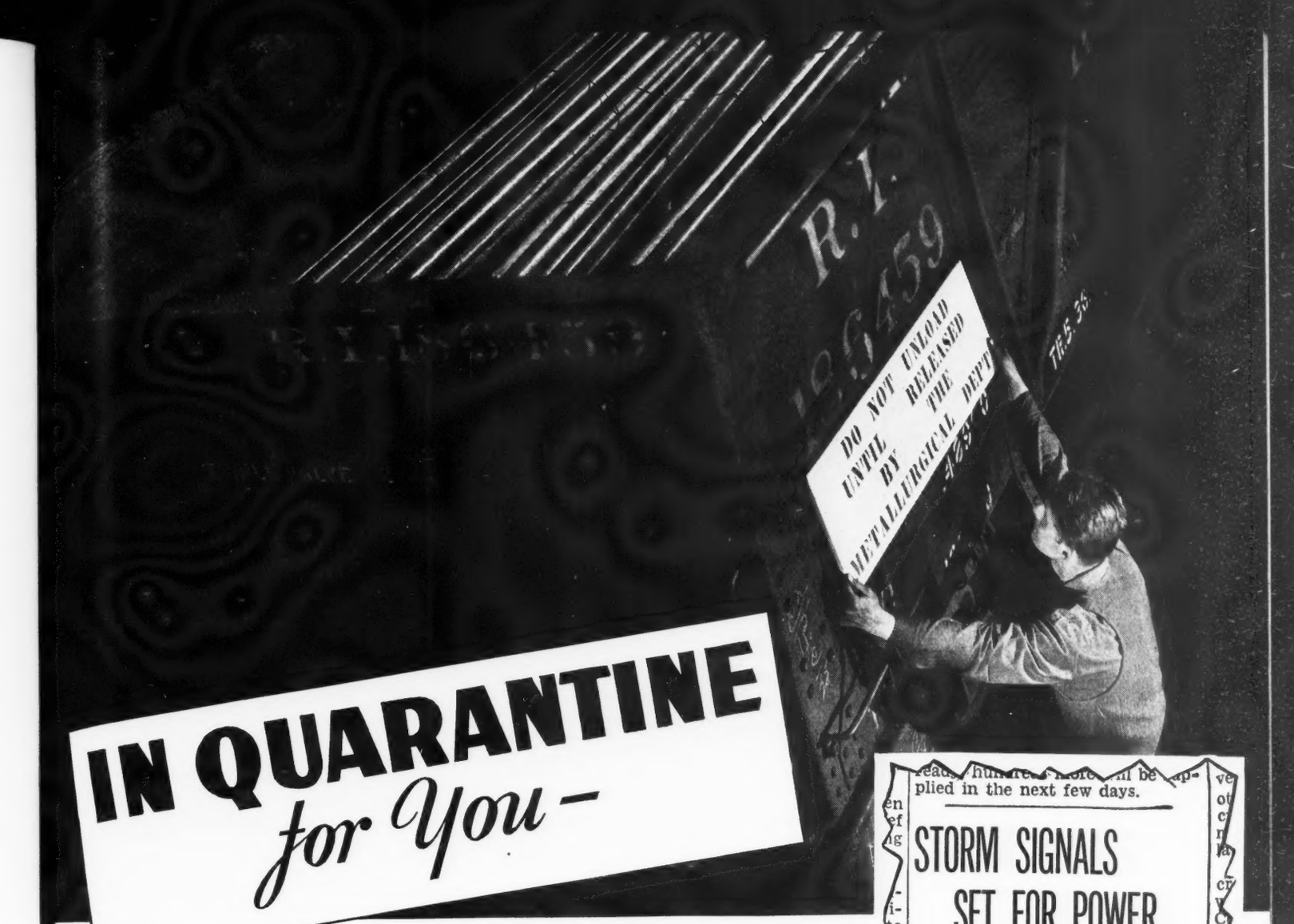
West Liberty has authorized extensions in municipal electric plant, including 450-bhp diesel-generator unit.

KANSAS——Alma plans municipal electric plant. Cost about $50,000. Paulette & Wilson, National Reserve Bldg, Topeka, consulting engineers.

St. Francis will soon award contract for







IN QUARANTINE *for You—*

NO immigrants anywhere ever get a more searching examination than do the materials ordered for Crane valves and fittings.

Though bought from the most reliable sources according to rigidly tested specifications, every shipment of material goes into "quarantine" at the Crane plants. There it stays until thoroughly tested in Crane laboratories.

This careful testing means that Crane is absolutely certain that materials are right before manufacture begins. It is only part of the elaborate system of tests and checks of tests throughout every Crane plant.

For after raw materials have been made into castings, the castings are checked and tested at every step through the various sub-assemblies, every part of a Crane product is tested, dimensions gauged and inspected. Finally, the finished valve or fitting is inspected as a whole before it leaves the plant.

There are over 33,000 gauges used in making certain that the dimensions of Crane valves and fittings are absolutely accurate. There is an army of inspectors whose only duty is to see that every Crane product is right in every part. Back of all this effort are the largest laboratories in the industry devoted to seeing that present products are properly made as well as working on new products for the future.

CRANE

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Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, PLUMBING AND HEATING MATERIAL

plied in the next few days.

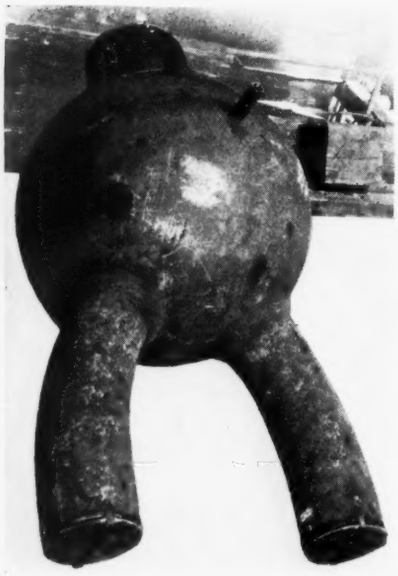
STORM SIGNALS SET FOR POWER PLANT ENGINEERS

CHICAGO, ILL., Sept. 27—Get ready for the loads that pile up on power plants when storm signals indicate that wintry blasts are due. Loads for lighting, loads for heating, loads for production—power plants have to take up one or more of these loads as the days grow shorter.

Prepare for unfaltering service by overhauling your piping lines now. CranEquip wherever you suspect that there is a chance of failure. Then you will have protected yourself as best you can—and the winter will not hold as many horrors for you.

Use your Crane No. 52 Catalog to pick out the items which you need. Get the work done while warmer weather is still with us and save on maintenance costs. CranEquip and know piping satisfaction.

Visit the Crane exhibit at the Chicago Exposition of Power and Mechanical Engineering—Booths 1 and 2—New International Amphitheatre, Chicago, October 4 to 9.



MAN OF STEAM—Waterside's (Consolidated Edison Co of New York, Inc) recently installed steam header receives steam from two 500,000-lb. per-hr boilers at 925 F and 1,250 lb per sq in and delivers it to a 50,000-kw turbine. The header is shown after completion at the shops of M W Kellogg Co, Jersey City, N. J.

300-hp diesel-generating unit. Cost about $35,000. E. T. Archer & Co, New England Bldg, Kansas City, Mo., consulting engineers.

McPherson contracted Combustion Engineering Co for high-pressure boiler unit and auxiliary equipment for municipal power plant. Cost about $70,000.

KENTUCKY——Williamstown plans municipal electric plant. $28,000 through Federal aid.

Board of Trustees, St. Joseph's Hospital, Lexington, has authorized new boiler house. Joseph R. Giannini, 710 Georgetown Pike, architect.

LOUISIANA——Interstate Natural Gas Co., Ferriday, plans 22-in. welded-steel pipeline from point on Mississippi River to Ferriday for natural-gas distribution. Cost about $75,000.

Caddo Pipe Line Co, First National Bank Bldg, Shreveport, has authorized surveys for 6-in. welded-steel pipeline from Lisbon to Homer, about 10 miles. Cost over $60,000.

Canal Bank Bldg, Baronne and Common Sts, New Orleans, plans air-conditioning plant and system in 18-story building. Leo S. Weil and Walter B. Moses, 427 South Peters St, engineers.

MAINE——Portland Fish Co, Custom House Wharf, Portland, will install cold storage and refrigerating plant in new building on waterfront. Cost over $70,000.

MARYLAND——Southern Maryland Tri-County Cooperative Assn, Inc, Welcome, plans electric plant at Popes Creek. To include three diesel-generator units and accessories. $50,000 arranged through Federal aid. Wendell M. Reed, president.

Washington Gas Light Co, 16 Carroll Park, Takoma Park (Montgomery County), plans extensions in gas-distributing system. Cost about $50,000.

Kunkle & Haverstick, 806 Light St, Baltimore, contracted Kirson Construction Co for boiler house and brick stack at baking plant. Cost over $45,000.

MASSACHUSETTS——Norwood plans municipal electric plant. Surveys and estimates of cost are being made.

Shawinigan Resins Corp, 50 State St.

(Further Straws on page 120)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Livermore — Alameda Co., plans by W. G. Corlett, Bank of America Bldg., Oakland, central heating plant for Arroyo Sanatorium.

Calif., Millbrae—Pacific Gas & Electric Co., 245 Market St., San Francisco, completing plans sub-station to house four 1,000 kva. transformers, switches, oil circuit breakers, etc. Private plans.

Calif., Sacramento—Sacramento Municipal Utility Dist. plans steam electric generating unit and distributing system. Total est. $12,000,000. P.W.A. allotted $4,000,000.

Colo., Greeley—Home Gas & Electric Co., plans electric power sub-station and additions to lines, etc., $170,000.

Fla., Orlando—Bids Oct. 4, by Orlando Utilities Comn., Orlando, steam electric power plant. $600,000. Robert & Co., Bona Allen Bldg., Atlanta, Ga., engrs.

Idaho, Bliss—B. W. Clark, Governor, has filed an application with state reclamation commissioner to establish a hydro-electric plant on Ticesha site on Snake River near here. Federal Aid would be sought, $2,500,000.

Idaho, Boise—City, City Hall, granted permission for power development on Payette River with storage facilities on Salmon River watershed, designed to furnish 12,000 h.p., storage dam, reservoir and pipe line to be built on south fork of Payette River 2 mi. above Banks, with power plant at end of pipe line; another dam on north fork of Payette, also 2 mi. above Banks, with 900 ft. tunnel through the divide to the south fork; another reservoir would be formed on Cape Horn Creek and Warm Springs Creek. $350,000. J. F. McBirney, City Hall, engr.

Ill., Chicago—Atchison, Topeka & Santa Fe R. R. Co., 179 West Jackson Blvd., plans 43x90 ft power house, 18th and Westworth Sts, $40,000. G. W. Harris, 80 East Jackson Blvd., engr.

Ill., O'Fallon—City plans municipal light and power plant building, equipment and distribution system. $176,000. $79,200 P.W.A. grant.

Ind., Crawfordsville — Municipality plans electric light and power plant improvements. $285,000.

Ia., Pella—Bids Oct. 5, by City, improving light and power plant, incl. altering building and equipment foundations, piping for new power plant equipment, altering switchboard and station wiring.

Ia., Rockwell City—City, delayed opening bids to have been taken July 29, for constructing power plant and equipment, because of stay obtained by private utility. $175,000. Young & Stanley, Muscatine, engrs.

Kan., Alma—City, C. O. Nelson, clk, sketches power plant and equipment. $50,000. Paullette & Wilson, Natl. Reserve Bldg., Topeka, engrs.

Kan., Hays—Central Kansas Power Co., Abilene, plans steam electric power plant. To exceed $40,000.

Kan., Kansas City—State Bd. Administration, c/o J. A. Mermis, bus mgr. Topeka, plans by R. A. Coolidge, state archt., Topeka, power plant improvements at University of Kansas Hospital. $68,181. P.W.A. grant approved.

La., Abbeville — City, A. J. Frank, supt. Water and Light Plant, soon takes bids new 1,000 h.p. power unit, also enlarge power building. Est. $55,000.

La., Bossier City—Bids to be asked from engineers to make a survey to determine advisability of installing a municipal light and power plant. $200,000.

Md., Popes Creek—Southern Maryland Tri-County Co-operative Assn, Welcome, applied to Pub. Serv. Comn. for permission to erect generating plant, $50,000. R.E.A. funds already provided, in addition to $165,000 loaned to erect power lines.

Mich., Adrian—Michigan Rural Electrification Corp., Inc., plans electric generating plant. Est. $130,000. R. A. White, c/o Owners, engr.

Mich., Bessemer—City plans brick, rein.-con., steel power plant and distribution system, plain found., involving two 320 kw Diesel engine driven 2,300 volt, 3 phase, 60 cycle generators, two 15,000 gal. oil storage tanks and cooling water pond. $187,500. P.W.A. approval granted.

Mich., Milford—Ford Motor Co., Dearborn, plans concrete dam and power plant at lower millpond on tributary to Huron River, hydro-electric power to be used for operation of small industrial plant. Est. about $50,000. Private plans.

Mich., Ubley—Thumb Electric Co-Operative, c/o F. Nelson, Ubley, plans electric power plant and distribution lines. Est. $300,000.

Neb., Alliance—City voted to construct new power plant building and install new 30,000 lb. per hr. pressure boiler and large turbine generator. Est. about $250,000. Voted for issuance $242,700 revenue bonds for project. Application filed with P.W.A. Burns & McDonnell, 107 West Linwood St., Kansas City, Mo., engrs.

Neb., Haigler—City plans improving light plant. $40,850. P.W.A. allotment approved. R. Fulton, Lincoln, engr.

N. Y., Buffalo—Buffalo Niagara Electric Corp., Buffalo, Col. W. Kelly, pres., plans constructing new 80,000 kw power plant in Niagara Falls or just north of here in Niagara River. $8,000,000. **Maturity 1938.** Private plans.

New York—Consolidated Edison Co., 4 Irving Pl., New York, plans betterments and plant additions and distribution services at various locations. $50,000,000. Owner will finance by security issue.

N. D., Lisbon—State Bd. Charities & Corrections, Bismarck, plans new power plant building, furnishing, installing necessary boiler equipment, concrete pipe tunnels to main and hospital buildings, at State Hospital. $45,450. P.W.A. allotment approved. W. F. Kurke, Fargo, archt.

O., Cleveland—Cleveland Electric Illuminating Co., W. H. Hartman, purch. agt., 75 Public Sq., plans completed 33x101 ft. electric sub-station, West 150th St. and Lorain Ave., $80,000 and 70x120 ft. and 120x120 ft. garage and laboratory, Miles Ave., $160,000.

Okla., Blackwell—City voted bonds enlarging municipal power plant. $300,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Okla., Wagoner — City made preliminary plans municipal light and power plant. $55,000. Engineer not appointed.

Oregon—Inland Power & Light Co., Public Service Bldg., Portland, plans dam and hydro electric power plant improvements, at Cove Power Plant on Crooked River, engineering division of Electric Bond & Share Co., 2 Rector St., New York, engr.

Ore., Klamath Falls—Enterprises Irrigation Dist. soon takes bids construction power plant. $68,000 P.W.A. grant $28,000. Landholders of enterprise irrigation district vote bond issue $40,000.

Pa., Petroleum Center (Oil City, P.O.)—Frampton Oil Co., Oil City, plans purchasing and installing power plant equipment, incl. gas engines, compressors, eccentric units and other machinery to replace equipment recently destroyed by fire. $1,000 plus. Private plans.

Tenn., Nashville—Tennessee Electric Power Co., J. C. Gould, Jr., pres., 605 Church St., authorized by Tennessee Public Utilities Comn. to build steam generating plant at Bordeaux near here, to supply power in Nashville area. Work will proceed as soon as authority is obtained from Federal Power Comn.

Tex., Grand Falls—Red Bluff Water Power Control Dist, c/o E. B. Barron, pres., making plans constructing auxiliary power plant on Pecos River, transmission lines southeast to Imperial and northwest through Barstow to connection near Patrole with line already built from dam to Pecos. $200,000. P.W.A. project. J. B. Shaw, Houston, engr.

Virginia—Bids Oct. 18, by Chief Division Purchases, Sales & Traffic, Dept. Agriculture, Wash., D. C., constructing East and West Laboratory buildings; four 2 story units, with connecting tunnel, 48x62 ft. boiler house, pumping, heating, ventilating, air conditioning equipment, all above at Arlington Research Station, Arlington Co.

Va., Lively—Northern Neck Electric Co-operative, plans electric light and power plant with distribution lines. $180,000.

Wash., Buckley—State Washington, Olympia, plans by Graham & Painter, Dexter Horton Bldg., Seattle, custodial school, incl. construction nine buildings, several 2 story rein.-con. dormitory buildings, central heating and power structure, hospital, administration building and kitchen. $590,000. P.W.A. grant pending.

Wash., Friday Harbor—Orcas Light and Power Co., c/o H. T. Cayou, Deer Harbor, soon takes bids constructing 50 mi. distribution line and 150 K. W. diesel powered generation plant. REA funds allotted, est. $50,000. T. C. Smith, Gregory Heights, Seattle, engr.

Wash., Seattle—University of Washington, Seattle, takes bids about October 1, 1 story 50x70 ft. addition to boiler plant and installation of boiler, $100,000. L. Bouillon, 1411 Fourth Ave., engr.

W. Va., Wheeling—Municipality having surveys made for electric light and power plant. C. J. Simon, Van Wert, engr.

Wyo., Green River—Utah Power & Light Co., Kerns Bldg., Salt Lake City, Utah, improving Green River Power Plant, incl. installation 500 kw steam turbine and new boiler, own forces. **$30,000.** J. A. Hale, Salt Lake City, engr.

Man., St. Boniface—Swift Canadian Co., Ltd., Winnipeg, R. B. Hunter, genl. mgr., plans constructing power plant and machine shop. $300,000.

N. S., Cowie's Falls—Nova Scotia Power Comn., Halifax, plans hydro electric development. $2,000,000.

Ont., Sault Ste Marie—Great Lakes Power Co., 527 Queen St. E., J. A. McPhail, pres., making plans 10,000 hp. development on Montreal River. $1,000,000. Private plans.

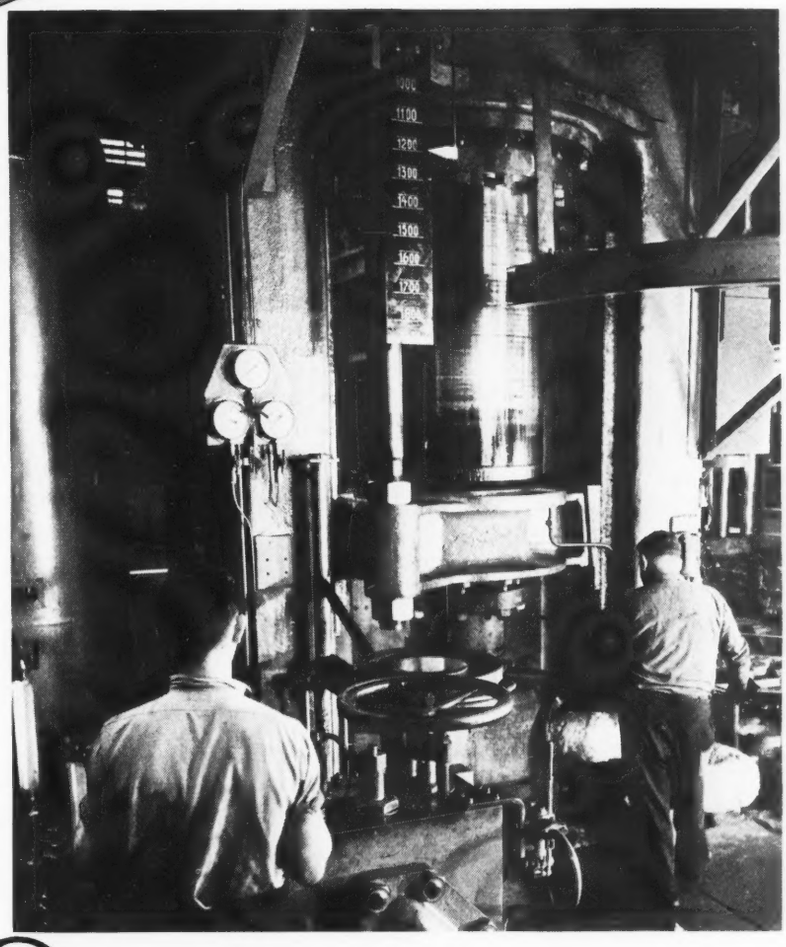
SCOVILL

EXTRUDED CONDENSER TUBES

In the manufacture of tubes by this process, the constituent metals are melted in an electric furnace. At the correct pouring temperature the metal is cast into a solid cylindrical billet. After cooling, the billet is sent to the saws and cut into extrusion lengths. Next, these billet sections are heated to exactly the correct temperature for extrusion, then extruded in a huge hydraulic press.

Elaborate precautions are taken in timing, temperature, control and speed of operation to hold the metal temperature during the extrusion well within the safe hot working range of the alloy being produced. Subsequent reducing and drawing operations bring the tubes down to finish size. The entire metal-working schedule is accurately shown on a chart which specifies the exact amount of drawing between anneals, the temperatures and duration of the anneal, and the final grain size to which the tubes must be finished.

A new booklet, "Scovill Condenser Tubes," gives detailed information about this process and describes carefully the many phases of condenser tubing from its manufacture to its installation. It will be sent on request of engineers or purchasing agents. Write Scovill Manufacturing Company, 13 Mill Street, Waterbury, Connecticut.



This Scovill hydraulic press punches out a core of metal from the heated billet, then inserts a mandrel in the space where the core has been removed and extrudes the metal between the mandrel and die, directly producing a heavy walled tube shell.

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WATERBURY, CONNECTICUT

SCOVILL CONDENSER TUBES PROVE DEPENDABLE

Dead Men

Read No Tombstones . . .

If with pleasure you are viewing any
work that I am doing,
If you like me or you love me, tell me
now.
Don't withold your approbation 'til the
parson makes oration,
And I lie with snowy lilies o'er my
brow!
For no matter how you shout it, I won't
care a bit about it,
I'll not know how many teardrops you
have shed.
If you think some praise is due me,
now's the time to slip it to me,
For I cannot read my tombstone when
I'm dead!

That old poem was pasted up in the first boiler room I ever worked in. It has stuck with me ever since, because it is one of the truest things I've ever read.

I've known many a boss who was ready to criticize, to cuss and to fire, but not nearly so many who were men enough to give credit where it was due. They were just plain afraid of their own jobs if they admitted that anybody who worked for them had even a lick of sense. They were big-headed, but not big-hearted—it takes an all-around big man to admit that somebody down the line had an idea he should have had himself.

I don't mean by that you should never criticize; any man worth keeping is worth correcting. But remember that even a looking glass has two sides; criticize when and where it is needed, but don't be niggardly with credit and compliment when deserved. It's a strange man who, if he learns that good work is appreciated, will not do his darndest to give the best he has in him.

George Edwards

GEORGE EDWARDS
Engineer

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CREASED AND CORRUGATED "*Flexibility*" FOR

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Pittsburgh Piping Creased Bends retain their original wall thickness . . . They can be made on short radii . . . And when combined with Corrugated Tangents they offer exceptional flexibility regardless of the type of installation.

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His gaskets did so well he worked himself right out of the engine cab into a little shop where he was soon making all the gaskets used on that particular railroad. Thus was the Goetze Gasket business founded. For 50 years it has flourished. During this period the World has seen its greatest industrial development . . . and Goetze grew with it, made gaskets, millions of them, for all industries and all purposes . . . gaskets engineered to meet innumerable conditions and requirements . . . the best gaskets skill and experience could produce. Let us tell you more about them. Goetze Gasket & Packing Co., Inc. 10 Allen Avenue, New Brunswick, New Jersey.

Goetze for GASKETS

STRAWS (Continued)

Boston, plans boiler house at new chemical plant at Indian Orchard. Cost close to $100,000. McClintock & Craig, 458 Bridge St, Springfield, consulting engineers.

Lawrence plans extensions in municipal pumping station. Cost about $90,000. Metcalf & Eddy, Statler Bldg, Boston, consulting engineers.

MICHIGAN——Briggs Mfg. Co, 11631 Mack Ave, Detroit, contracted H. F. Martin Const Co, 955 E Jefferson St, for addition to power house at automobile plant. Cost over $60,000.

Bay City plans municipal light plant, with coal unloading and mechanical-handling plant from waterfront to station site, and complete electrification of municipal waterworks. Cost $790,000. Financing through Federal aid.

State Dept of Bldgs, Capitol Bldg, Lansing, plans steam-electric plant at Newberry. Cost about $250,000. Derrick Hubert, 1065 Sheridan Rd, Menominee, architect; E. R. Little, Ford Bldg, Detroit, engineer.

Traverse City plans improvements in municipal light plant. Cost $125,000. Federal aid.

Bessemer plans municipal electric plant Cost about $187,000. Federal aid.

Flint plans municipal steam-electric station. Cost close to $18,650,000. Federal aid.

Michigan Rural Electric Corp, Adrian, plans steam-electric plant. Cost about $125,000. Federal aid. R. A. White, engineer.

Baldwin Rubber Co, Pontiac, contracted Harlan S. Smith, Pontiac, for boiler plant and coal bunker at mill. Cost close to $50,000.

Mount Pleasant plans municipal electric plant and electrical distributing system. Cost about $538,000. Federal aid.

Independent Assn of Natural Gas Producers of Michigan, Roy F. Ide, Davis-Stott Bldg, Detroit, representative, plans welded-steel pipelines from Six Lakes about 400 miles total, for natural gas transmission. Cost over $2,500,000.

MINNESOTA——Lake Crystal has secured fund of $44,550 through Federal aid for municipal light plant. Will include diesel-generator units and accessories. G. M. Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

R. A. Winkler, Brainerd, heads cooperative association to construct and operate local cold-storage and refrigerating plant. Cost over $45,000.

Worthington plans modernization of coal-handling and storage system at municipal power plant. Work will be carried out early in 1938.

Detroit Lakes contracted Fuel Economy Engrg Co, New York Bldg, St. Paul, for turbine-generator and condenser, at $73,950, and for boiler and stoker, at $64,040, for extensions in municipal power plant. Also for cooling tower to Marley Co, Kansas City, Mo., at $9,170.

Roseau contracted Fairbanks, Morse & Co, Chicago, for 375-hp diesel-generator unit and auxiliaries.

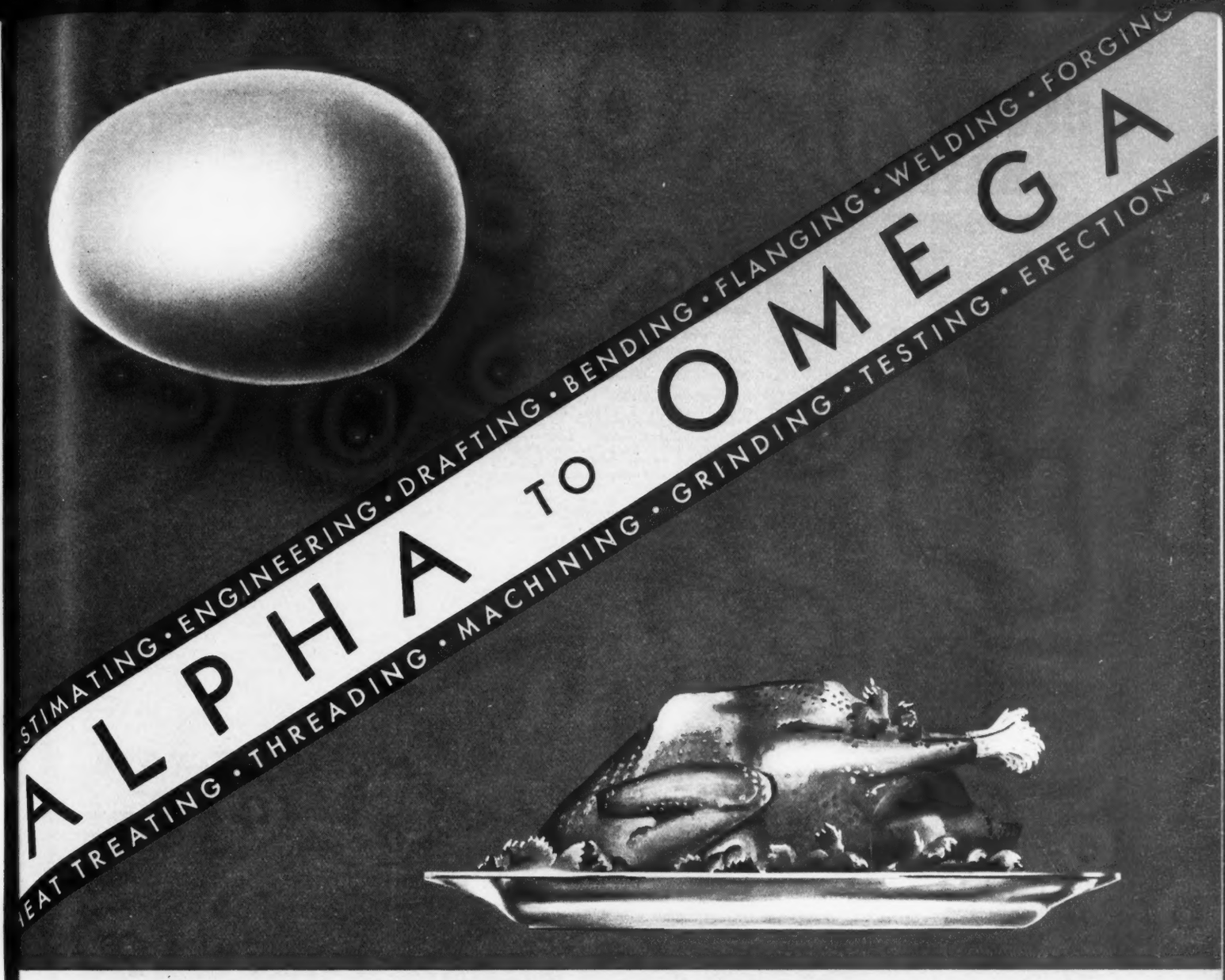
MISSOURI——Rockport has secured Federal grant of $47,270 for municipal electric plant, and $18,888 for ice and refrigerating plant. Engineering Service Co, Railway Exchange Bldg, Kansas City, consulting engineer.

NEBRASKA——Haigler plans municipal electric plant. Cost $41,000. Federal aid. C. Robert Fulton, 2327 South 19th St, Lincoln, consulting engineer.

School of Agriculture, University of Nebraska, Curtis, contracted Kingery Const Co, 1921 Y St, Lincoln, for power house at institution. Cost over $60,000.

Holdredge contracted Fairbanks, Morse & Co, for diesel-generator unit and accessories at $58,291.08.

(Continued on page 122)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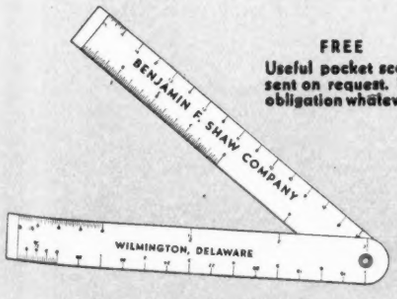

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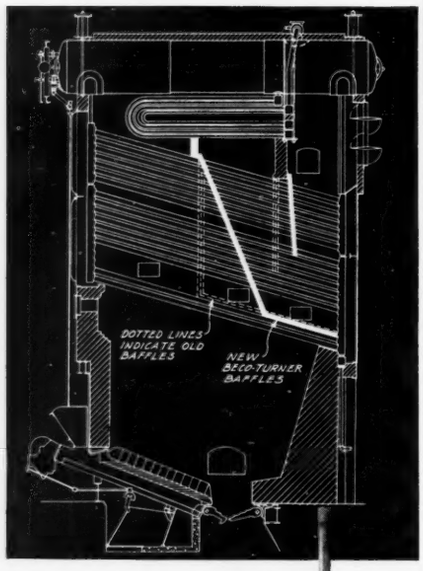

Increase efficiency and capacity

Scioto Power Station, Marion, Ohio, showing Beco-Turner inclined baffles in 800-hp. boiler.

IN many cases, it is possible to improve the operation of water tube boilers by the installation of new Beco-Turner baffles which are designed to bring about maximum efficiency and capacity.

In the Beco-Turner installation shown above, note how gas passages were redesigned to conform to the diminishing volume of the gases as their heat is given off to the tubes. This improvement gives more uniform gas velocity, reduces stack temperatures, and increases efficiency by making all of the tube surface effective as a heat-absorbing medium.

At the same time, this change increases capacity by locating a greater percentage of the tube surface in the first pass. It eliminates furnace congestion by "opening up" the boiler.

Constructed of self-hardening refractory material, Beco-Turner baffles fit snugly around the tubes. They are distinguished by their patented expansion joints which keep them gas tight. Mail coupon for interesting catalog.

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Send blueprints and our engineering department will submit any possible recommendations for improving your baffle design.
P 10-37

STRAWS (continued)

NORTH CAROLINA——Ocracoke Power & Light Co, Ocracoke, plans for steam-electric station and electrical distributing lines. Cost over $75,000. Federal aid.

Liggett & Myers Tobacco Co, Durham, contracted George W. Kane, Snow Bldg, for addition to power house at local plant. Cost over $80,000.

NEW YORK——Bureau of Yards and Docks, Navy Department, will make extensions and improvements in electric and compressed air lines at ship ways at Brooklyn Navy Yard.

National Lead Co, 111 Broadway, New York, plans power house at lead smelting and reclaiming plant on Trinity River, near Dallas, Tex. Cost over $500,000.

East River Station of Consolidated Edison Co of N. Y., Inc., has extended application of Kirkaldy system of protection against scale and corrosion to include two-high-pressure bleeder heaters. The system was first installed on a 45,000-sq ft condenser some time ago.

Jamestown is considering municipal artificial-gas plant and distributing system. Special election soon to approve bond issue of $1,500,000 for project. L. L. Graham, city engineer.

OHIO——Terminal Cold Storage & Ice Co, 38 Eaker St, Dayton, contracted B. G. Danis Co, 1530 East First St, for 2-story addition to cold storage and refrigerating plant, 61x82 ft. Cost over $45,000.

Department of Public Service, City Hall, Columbus, has low bid from Wickes Boiler Co, Saginaw, Mich., at $125,720 for new boiler unit of 12,500-sq ft heating surface, and from Westinghouse Electric & Mfg Co at $45,193 for multiple-retort underfeed stoker, both for municipal power plant, and will make award soon.

Painesville contracted Payne & Boymer Co, Painesville, for extensions in municipal electric plant. Cost about $400,000. Ralph Hadlow, 700 Prospect Ave, Cleveland, engineer.

OKLAHOMA——Blackwell has authorized bond issue of $300,000 for extensions in municipal power plant. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

PENNSYLVANIA——Pennsylvania General State Authority, State Capitol Bldg, Harrisburg, plans improvements in power house at State Village, Laurelton, Union County; also will make additions and betterments in steam and electric distributing systems. Fund of $1,225,000 through Federal aid.

TENNESSEE——Tennessee Electric Power Co has been authorized to construct a $2,000,000 steam plant at Bordeaux. Turbine-generator has been completed and tested at General Electric Co's Schenectady plant; other equipment is on order.

Building Committee, Vine Street Orphans Home, Chattanooga, will build central-heating plant for 2-story basement institutional home at Germantown and Rogers Rds. Cost about $200,000. Louis H. Bull, Chattanooga, architect.

TEXAS——Cleveland plans gas engine and accessories for standby service for municipal water-pumping station. Also two motor-driven deep well pumping units with capacity of 250 gpm and booster pumping equipment, with 100,000-gal steel tank and tower. Cost about $120,00 with pipeline distributing system. Financing through Federal aid.

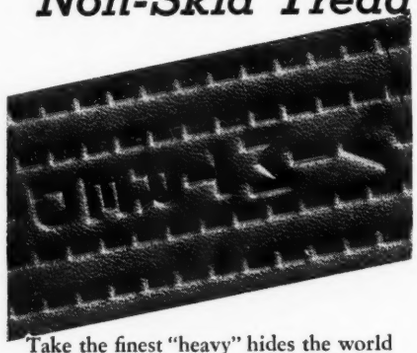
East Texas Refining Co, Tower Petroleum Bldg, Dallas, plans natural-gas control and distributing plant in Rodessa gas field area, Miller County, Ark. Cost close to $10,000 with compressor station and other operating units.

American Liberty Pipe Line Co, First National Bank Bldg, Dallas, has authorized 6-in. welded-steel pipeline from Sulphur Bluff oil field area to point near Weaver, about 8 miles, for crude-oil transmission. Cost over $75,000.

Rockport plans municipal light plant, with installation of two 200-kw diesel generator units, cooling tower and auxiliary equipment. $105,000 through Federal Aid.

VIM TRED

—the Belt with the Non-Skid Tread



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